TENNESSEE DEPARTMENT

OF

ENVIRONMENT AND CONSERVATION

DOE OVERSIGHT DIVISION

ENVIRONMENTAL MONITORING PLAN

JANUARY through DECEMBER 2008

Pursuant to the State of Tennessee's policy of non-discrimination, the Tennessee Department of Environment and Conservation does not discriminate on the basis of race, sex, religion, color, national or ethnic origin, age, disability, or military service in its policies, or in the admission or access to, or treatment or employment in its programs, services or activities. Equal employment Opportunity/Affirmative Action inquiries or complaints should be directed to the EEO/AA Coordinator, Office of General Counsel, 401 Church Street, 20th Floor, L & C Tower, Nashville, TN 37243, 1-888-867-7455. ADA inquiries or complaints should be directed to the ADA Coordinator, Human Resources Division, 401 Church Street, 12th Floor, L & C Tower, Nashville, TN 37243, 1-888-253-5827. Hearing impaired callers may use the Tennessee Relay Service 1-800-848-0298.

To reach your local
ENVIRONMENTAL ASSISTANCE CENTER
Call 1-888-891-8332 OR 1-888-891-TDEC

This plan was published
With 100% Federal Funds
DE-FG05-96OR22520
DE-FG05-96OR22521

Tennessee Department of Environment and Conservation, Authorization No. 327023, 50 copies. This public document was promulgated at a cost of $3.27per copy. January 2008.

TABLE OF CONTENTS

INTRODUCTION……..…….……i

AIR QUALITY MONITORING
Monitoring of Hazardous Air Pollutants (HAPs) at the East Tennessee Technology Park (ETTP)…….1
Monitoring of Hazardous Air Pollutants at Y-12 and X-10……...4
RadNet Air Monitoring on the Oak Ridge Reservation ……7
Monitoring Fugitive Radioactive Air Emission on the Oak Ridge Reservation……9
Perimeter Air Monitoring on the Oak Ridge Reservation……11
RadNet Precipitation Monitoring on the Oak Ridge Reservation……14

BIOLOGICAL /FISH AND WILDLIFE MONITORING
Threatened and Endangered Species Monitoring ……17
Benthic Macroinvertebrate Monitoring ……...21
Diatom (Periphyton) Environmental Monitoring ……....24
Canada Geese Monitoring ……...31
Monitoring Aquatic and Terrestrial Plants in Surface Water and Ecological Habitats on the Oak Ridge Reservation ……..…34

DRINKING WATER MONITORING
Sampling of Oak Ridge Reservation Potable Water Distribution Systems……..…41
RadNet Drinking Water Program on the Oak Ridge Reservation ……...44

GROUNDWATER MONITORING……47

RADIOLOGICAL MONITORING
Facility Survey Program and Infrastructure Reduction Activity……..53
Haul Road Radiological Surveys……..56
Ambient Gamma Radiation Monitoring of the Oak Ridge Reservation Using Environmental Dosimetry……..58
Real Time Monitoring of Gamma Radiation on the Oak Ridge Reservation……...60
Surplus Material Verification……62

SURFACE WATER MONITORING
Monitoring of Liquid Effluents at the Environmental Management Waste Management Facility……63
Rain Event Surface Water Monitoring ……66
Ambient Sediment Monitoring ……69
Ambient Surface Water Monitoring ……73
Surface Water (Physical Parameters) Environmental Monitoring ……..76
Ambient Trapped Sediment Monitoring ……..……79

APPENDICES
Appendix A - Acronyms……..82
Appendix B - Job Hazard Analysis……..……86

INTRODUCTION

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy (DOE) Oversight Division (the Division), under terms of the Tennessee Oversight Agreement Section A.7.2.1, is providing an annual environmental monitoring plan for the calendar year 2008. The plan consists of a series of individual work plans describing independent environmental monitoring and surveillance. Oversight of DOE's environmental monitoring and surveillance programs is also described. Chemical and radiological emissions in the air, water, biota, and sediment on the Oak Ridge Reservation and environs are emphasized. The goal is to assure that DOE's Oak Ridge Operations have no adverse impact to public health, safety, or the environment. Results from our monitoring and our findings of the quality and effectiveness of the DOE's environmental programs are reported in our quarterly and annual status reports. An annual environmental monitoring report which details the technical results of these studies is also provided each spring.

This plan offers the Department of Energy the opportunity to review and consult on the Division's monitoring activities and to take split samples as needed. For situations such as storm events, non-permitted discharges, emergencies or spills, we may perform short-notice or no-notice sampling. DOE will be informed as soon as a decision is made to take short-notice or no-notice samples. Environmental monitoring is a dynamic process and will periodically change. Major changes to this plan will be made in writing to DOE.

The Division or the Tennessee Department of Health, Environmental Laboratory and Microbiological Laboratory Organization (Laboratory Services) will process quantitative chemical samples. Laboratory Services has expertise in a broad scope of services and analyses. Certain analyses and quality assurance/quality control (QA/QC) samples are subcontracted out by Laboratory Services to independent certified laboratories. Bench level QA/QC records and chain-of-custody records are maintained by Laboratory Services for all samples collected by the Division. The Laboratory Services Standard Operating Procedures are followed and also serve as a guide to the Division's laboratory procedures. General sampling and analysis methods follow EPA guidelines.

Benthic macroinvertebrates and other biological samples are taxonomically identified at Laboratory Services, in the Division's laboratory, or by Laboratory Services subcontractors. Common water quality measurements and radiological readings are done in the field with calibrated instruments. Environmental dosimeters are analyzed by outside vendors. All work follows EPA, State, and instrument manufacturer's protocols as appropriate. Data loggers are used to reduce transcription errors.

Air Quality Monitoring

The Division's integrated air quality monitoring is designed to verify and enhance DOE monitoring of the air quality on the Oak Ridge Reservation and in surrounding areas which may be impacted from DOE Oak Ridge Operations. The Division implements EPA's RadNet ambient monitoring system (RadNet). TDEC staff provide radiological surveillance of ambient air quality in the vicinity of the ORR and compare the results to that of the national RadNet program. Three

precipitation monitors are now included in the Oak Ridge Reservation RadNet system from which radiological contaminants in rain and snow will be assessed. The ORR perimeter program is oversighted. In fact, the Division has arranged to use DOE's pre-filter media for its own radiological analysis and direct trend comparisons. Portable samplers are also set up to measure hazardous and radioactive contaminants around DOE demolition and remediation projects. In 2005, the Division added the Environmental Waste Management Facility (EMWMF) as an air-sampling site for fugitive emissions. Results are used to verify that DOE keeps contamination contained during cleanup and disposal activities. In the event of a large catastrophic release, any of these data could be used for consequence assessment and to guide recovery efforts, even in the community.

Biological Monitoring

The Division provides independent biological monitoring and oversight on and off the Oak Ridge Reservation to determine the impact of DOE operations. TDEC DOE-O also works in conjunction with the Tennessee Wildlife Resources Agency (TWRA), the Tennessee Valley Authority (TVA), and with other Tennessee Department of Environment and Conservation offices to coordinate valley-wide monitoring efforts related to fishing advisories. Specific contaminant pathways are investigated on the Oak Ridge Reservation as well. Results are used to formulate recommendations on clean up and to measure potential human and/or environmental risk. Division staff are currently measuring impacts to aquatic biota, contamination in geese, and other indicator species such as lichens and watercress. Invasive plants on a 3000-acre conservation easement are also currently being mapped.

Drinking Water Monitoring

Public water systems on the Clinch and Tennessee Rivers can be adversely impacted by DOE activities on the Oak Ridge Reservation. Independent drinking water monitoring supports the public water system's monitoring efforts related to releases from the Oak Ridge Reservation. The Division implements EPA's RadNet Drinking Water Program. Results are compared to the national program. TDEC provides labor and EPA provides expendables and analysis. Because DOE plant water distribution systems operate at a fraction of historical capacity and can stagnate, chlorine residuals can also be monitored in DOE facilities. The comprehensive goal is to document trends and ensure that systems continue to be safe from radiological, chemical, and bacteriological contamination.

Groundwater Monitoring

The Division's groundwater monitoring program provides information about Oak Ridge Reservation releases and potential impacts on health and the environment. Given the implications of contaminant transport off the Oak Ridge Reservation via groundwater, the Division will continue to emphasize the identification of groundwater pathways. This will be accomplished by monitoring water supplies, wells, and springs, both on and off the ORR and by conducting hydrogeological investigations such as aquifer evaluations and dye traces. Integration

of groundwater and surface water sampling results allows concepts of groundwater behavior to be refined. Much groundwater tracing is opportunistic, as weather and discoveries made during construction or remediation, etc. are among factors that affect sampling. Citizen reports of large springs in the ORR environs are useful and guide sample planning.

DOE has detected disposal area contamination in exit pathway monitoring wells installed between Melton Valley and the Clinch River. As a prudent measure, the Division intensified residential drinking water monitoring across the river from Melton Valley in 2007. This effort will continue into 2008 to assure the safety of residential well water users and to delineate possible offsite plumes.

Radiological Monitoring

The Division's radiological monitoring is directed toward the development of a comprehensive radiological monitoring system as prescribed by the Tennessee Oversight Agreement, Attachment C.2 *"Radiological Oversight."* The primary focus of the program is the detection of radiological contamination with the potential to impact human health and the environment. The Division's radiological program contributes in all media areas and reviews CERCLA, NEPA, waste disposition, and other projects involving radionuclides. Autonomous monitoring includes facility surveys, gamma monitoring of the ORR, footprint reduction surveys, surplus sales surveys, and real-time gamma monitoring around active demolition and remediation sites. Automated gamma monitoring is being done at the EMWMF in Bear Creek Valley, for example. The DOE weigh scales database is compared to Division gamma-monitoring data. radiation readings on waste shipments delivered for disposal are being monitored by using time stamps to match data. This assures the weighing and documentation of radioactive shipments also.

Surface Water Monitoring

The Division measures trends in the quality of water and sediments in the Clinch River and Oak Ridge Reservation tributaries. Surface water is one of Tennessee's most important economic and environmental resources, but local waterways rarely unconditionally meet all designated uses. For example, there are advisories on fish consumption from local reservoirs and streams. Legacy pollution from DOE, other industries, and non-point source origins are continuing problems. Long-term monitoring can define success or failure of clean-up actions, source controls, and attenuation. Specifically, the Division is analyzing water from Bear Creek to isolate legacy source inputs. It is hoped that the long-term monitoring strategy for the new Environmental Management Waste Management Facility can be positively affected and that existing sources/pathways can be found, analytically isolated, trended, and remedied.

From another perspective, the Clinch and Tennessee Rivers are drinking water sources for several municipalities. Knowing the pollutant concentration is vital to the monitoring of those drinking water sources. In 2008, monitoring and investigation will continue in closer proximities to remediation projects and new construction. The Division is also doing a significant amount of storm-event-related sampling. This will provide a better resolution in evaluating the success of clean-up and remediation efforts.

Invitation for Public Comment

This plan is published to inform the public about State sampling on the ORR and environs. Any comments from the public on where or how our future sampling should be done are greatly appreciated. Comments can be sent to:

Darlene Seagraves
TDEC DOE-O
761 Emory Valley Road
Oak Ridge TN 37830

Comments can also be sent to darlene.seagraves@state.tn.us or faxed to (865) 482-1835.

This page intentionally left blank.

AIR QUALITY MONITORING

Monitoring of Hazardous Air Pollutants at the East Tennessee Technology Park (ETTP)

Introduction

This independent monitoring project is conducted under authority of the Tennessee Oversight Agreement. It is a continuation of the ambient air-monitoring project initiated in 1997 in response to the heightened level of public concern regarding potential impacts to public health from the TSCA Incinerator emissions. Additionally, remediation and D&D activities at the site continue, and further analyses of the potential impacts of these projects on the ambient air on and around the ETTP site are warranted.

Through use of the Division's hi-volume ambient air samplers, levels of arsenic, beryllium, cadmium, chromium, lead, nickel and uranium (as a metal only) in the ambient air at the ETTP site will be monitored. Possible sampling locations have been selected through wind rose data indicating their presence in the prevailing wind flow directions at the ETTP site. The sites are as follows:

- K-2 Blair Road across from the TSCA Incinerator
- Station 42/TSCA-1 on Blair Road and,
- Station 35/TSCA-2 site on Gallaher Road. (See Figure 1)

Currently, the monitor is located at the K-2 site. DOE maintains an air monitor for metals and radiological emissions at this site. This location was selected on the basis of wind rose data and data collected by DOE. Although this project will sample for metals only, the Radiological Monitoring Oversight (RMO) program of the Department of Energy Oversight Division (TDEC) will continue ongoing radiological ambient air monitoring on the ETTP site. A background monitor will be located in the Oak Ridge area outside of the region of influence of sources of air emissions at ETTP.

Methods and Materials

On a weekly basis sample filters will be collected from the ETTP and background samplers. Composite samples will be analyzed quarterly by the State laboratory in Nashville or by one of their subcontractors according to EPA Method IO-3.5, which determines what metals are present in ambient air particulate using inductively coupled plasma/mass spectrometry (ICP-MS). The composite sample will be made giving each filter equal weight, but filters collecting particulate from air volumes that differ significantly from the quarterly mean sample volume by more than 20 percent will be sent to the State lab for individual analyses.

The sampler will remain at the K-2 site, which is closest to the TSCA incinerator, unless changing conditions at the site change monitoring priorities. However, the option of moving the sampler to one of the other locations listed above, or elsewhere around ETTP, is a possibility, should a need to do so be perceived by the staff.

Methods and protocols have been developed based on equipment maintenance manuals supplied by the manufacturers and sampling criteria tailored specifically to this project and DOE-O's mission and staffing levels (Thomasson, 2004 and other TDEC guidance). The sampler motor will be disassembled and the motor's brushes will be inspected for condition and evaluated for longevity at an interval less than two months since the last brush change. When it is not expected that the brushes will last until the next site visit, they will be replaced. Based on experience with the typical lifetime of the sampler motor, it will be changed about twice annually.

The sampler will also be inspected to ensure that the orifice remains level and parallel to the ground. At each site visit the sampling cartridge will be removed and replaced with one holding a new filter. The cartridge will be covered both top and bottom, and the sample will be removed at the DOE-O laboratory and placed in a zip-lock bag.

The 24-hour chart recording pressure differential will be removed and replaced weekly and its pen trace will be evaluated for average readings for the weekly period. Relevant information will be recorded on the reverse side of the chart. Readings of atmospheric pressure and ambient temperature are to be recorded on the chart, and the reading of the elapsed time indicator will also be taken. Proper chain-of-custody for samples will be maintained. DOE-O staff will maintain an annual calibration check that will be carried out in accordance with the manufacturer's specifications.

Reporting on the status of analytical results from each sampling location will be done quarterly. Mean values will be compared with reference to air concentrations from *Title 40 CFR 266*. They will also be compared to sampling results from DOE monitors around the ETTP site. Conclusions regarding current levels of HAPs metals in ambient air will be prepared in an annual report and included in the DOE-O environmental monitoring report.

Materials required for this project include:

hi-volume sampler	filters
sampler replacement parts	calibration kit
level	flow charts
extension cords	waterproof marking pens
tool kit	project data/custody forms
motor brushes	plastic sample bags

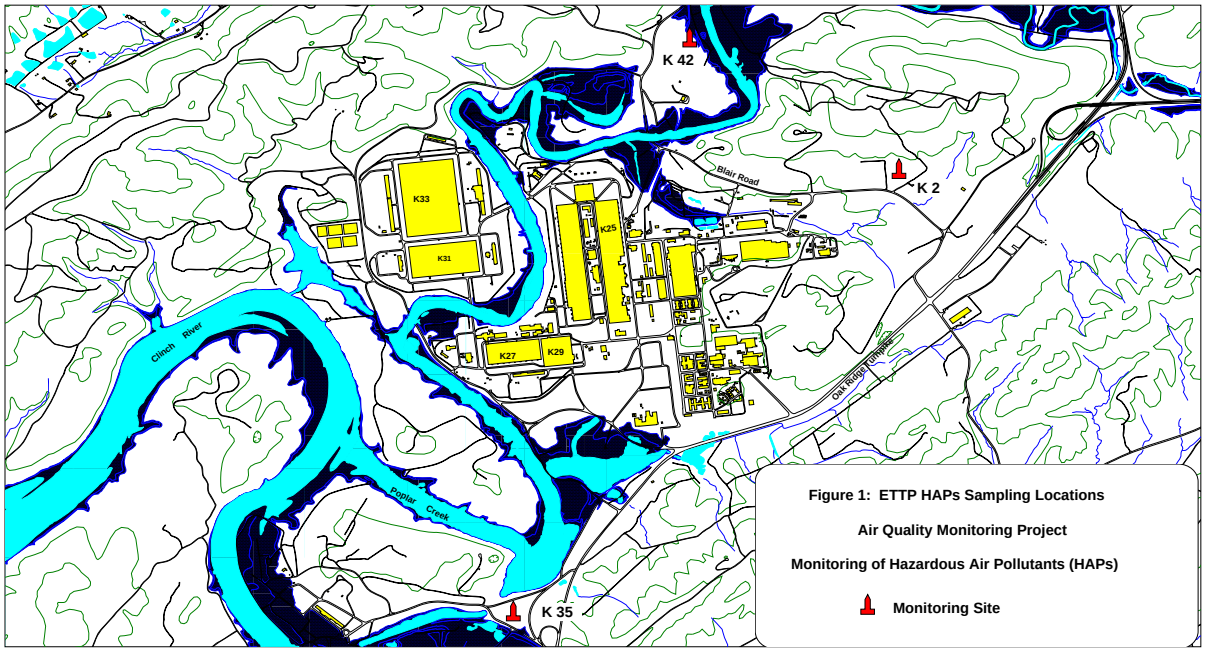

Figure 1: ETTP HAPs Sampling Locations

References

New York State Department of Environment Control, *Draft New York State Air Guide-1, Guidelines for the Control of Toxic Ambient Air Contaminants*, Appendix B of Air Guide-1, Ambient Air Quality Impact Screening Analyses, 1994 Edition.

Operations Manual for GMW Model 2000H Total Suspended Particulate Sampling System, Graseby GMW Variable Resistance Calibration Kit # G2835. 1998.

Tennessee Department of Environment and Conservation, TDEC DOE-O Procedure Number: SOP-ES&H-004 Air Monitoring/Air Sampling.

Tennessee Department of Environment and Conservation, *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee.* Oak Ridge, Tennessee. 2006.

Title 40 CFR Part 266 Appendix V. Boiler and Industrial Furnace Regulations

Thomasson D., *Health, Safety and Security Plan*, Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, Oak Ridge, Tennessee. 2005.

Monitoring of Hazardous Air Pollutants at X-10 and Y-12

Introduction

This independent monitoring project is conducted under authority of the Tennessee Oversight Agreement. It is a continuation of the ambient air-monitoring project initiated in 1998 in response to the public's concern regarding possible health effects resulting from the potential presence of hazardous air pollutants on and around the Oak Ridge Reservation (ORR).

In addition to the potential emissions of hazardous metals from plant operations on the ORR, ongoing remediation and demolition activities may act as sources of air pollution. Levels of arsenic, beryllium, cadmium, chromium, lead, nickel and uranium (as a metal only) in the ambient air near the Y-12 National Security Complex and ORNL facilities will be determined through use of the Division's hi-volume ambient air samplers. The goal of this project will be accomplished through locating samplers at predetermined sampling locations currently in use since the 2004 calendar year monitoring project. These locations were selected based on wind rose data, availability of electrical power, and co-location with DOE and TDEC radiological air monitors. The sites are as follows:

- ORNL: X-10E - RadNet station east of the main entrance to the site
- X-10C - station at the corehole 8 remediation site
- X-10W - Station No. 3 west of the site (See Figure 1)
- Y-12: Y-12E - RadNet station east of the plant entrance
  Y-12W - RadNet station west of the plant site (See Figure 2)

Although this project will sample for metals only, the Radiological Monitoring Oversight (RMO) program of the Department of Energy Oversight Division (TDEC) will continue ongoing radiological ambient air monitoring on the Oak Ridge Reservation.

Methods and Materials

On a weekly basis, sample filters will be collected from samplers. Composite samples will be analyzed quarterly by the State laboratory in Nashville using inductively coupled plasma and atomic absorption techniques. The composite sample will be made giving each filter equal weight, but filters collecting particulate from air volumes significantly differing from the quarterly mean sample volume by more than 20 percent may be sent to the State lab for individual analyses.

Samplers will typically be placed east of each site, which is generally in the direction of the maximum average wind speed. However, the samplers will remain on trailers and may be moved west of the sites, if desired, or at locations inside the site boundaries. Power supply at the X-10E site is provided via a temperature sensitive source, making deployment at this site potentially problematic during the coldest months. For the 2008 sampling year, the X-10 sampler will be located inside the X-10 plant at station X-10C, and samples are to be split with the radiological monitoring program.

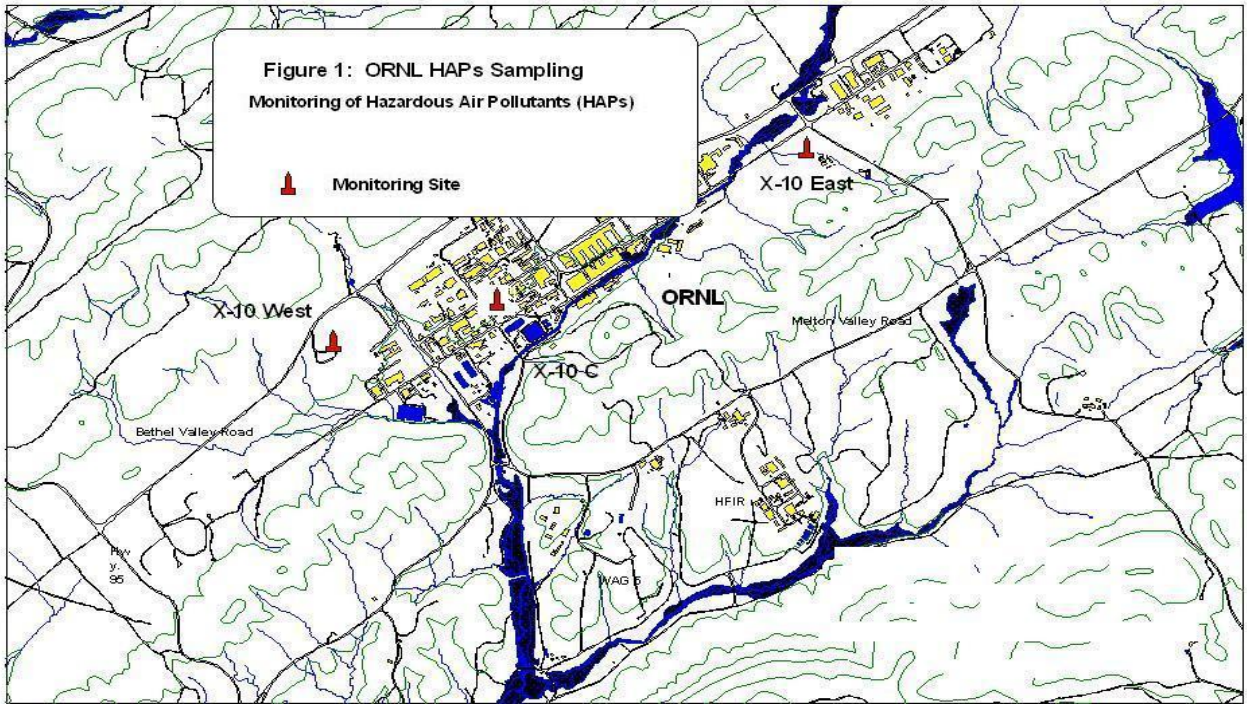

Figure 1: X-10 HAPs Sampling Locations

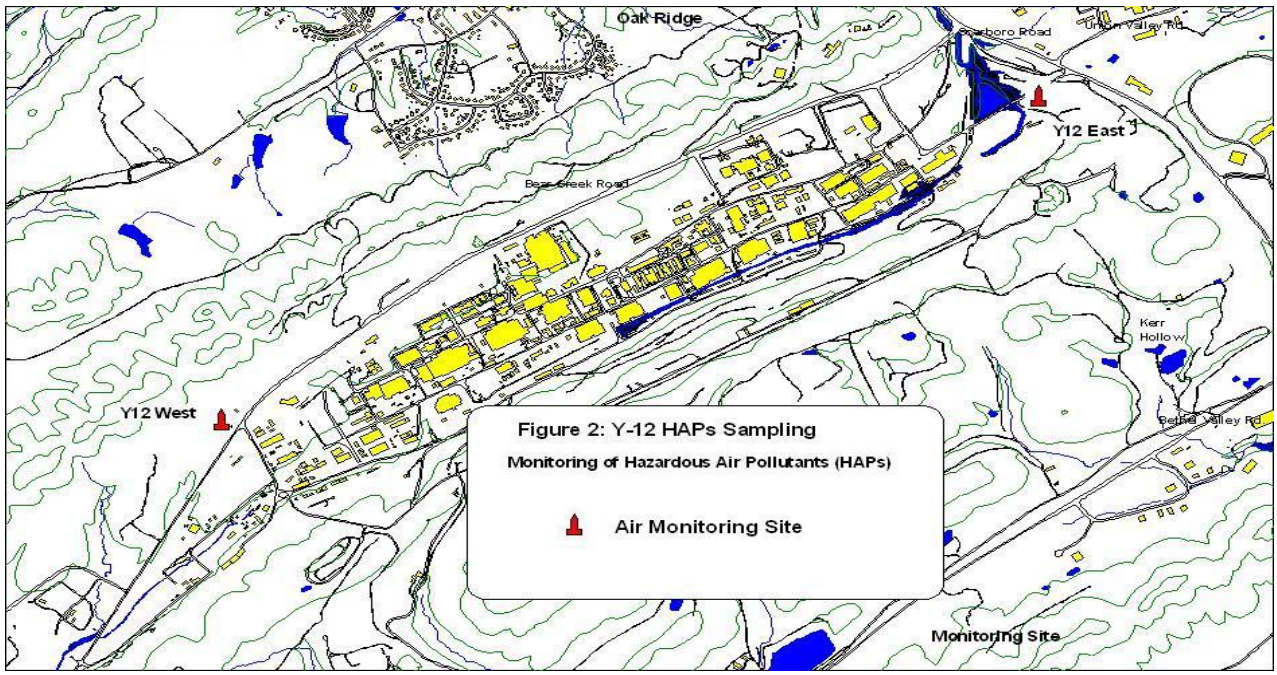

Figure 2: Y-12 HAPs Sampling Locations

At an interval less than two months since the last brush change, the sampler motor will be disassembled and the motor's brushes inspected for condition and evaluated for longevity. When it is not expected that the brushes will last until the next site visit, they will be replaced. Sampler motors will be replaced about every six months. The sampler will also be inspected to ensure that the orifice remains level and parallel to the ground. At each site visit the sampling cartridge will be removed and replaced with one holding a new filter. The cartridge will be covered both top and bottom, and the sample will be removed at the DOE-O laboratory and placed in a zip-lock bag. The 24-hour chart recording pressure differential will be removed and replaced weekly, and its pen trace will be evaluated for average readings for the weekly period. Relevant information will be recorded on the reverse side of the chart. Readings of atmospheric pressure and ambient temperature are to be recorded on the chart, and the reading of the elapsed time indicator will also be taken. Proper chain-of-custody for samples will be maintained. DOE-O staff will maintain an annual calibration check that will be carried out in accordance with the manufacturer's specifications.

A report will be generated detailing the analytical results from each sampling location. Upon completion of the project, a final report will be prepared presenting conclusions regarding ambient air HAPs metals.

Materials required for this project include:

hi-volume sampler	filters	extension cords
trailer	calibration kit	tool kit
level	flow charts	motor brushes
waterproof marking pens	project data/custody forms	plastic sample bags

References

New York State Department of Environment Control, Draft New York State Air Guide-1. G*uidelines for the Control of Toxic Ambient Air Contaminants,* Appendix B of Air Guide-1, Ambient Air Quality Impact Screening Analyses. 1994 Edition.

Operations Manual for GMW Model 2000H Total Suspended Particulate Sampling System, Graseby GMW Variable Resistance Calibration Kit # G2835. 1998.

Tennessee Department of Environment and Conservation, TDEC- DOE-O Procedure number: SOP-ES&H-004 Air Monitoring/Air Sampling

Tennessee Department of Environment and Conservation, *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*. Oak Ridge, Tennessee. 2006.

Title 40 CFR Part 266 Appendix V. Boiler and Industrial Furnace Regulations.

Thomasson, D.A. *Health, Safety and Security Plan*, Tennessee Department of Environment and Conservation Department of Energy Oversight Division, Oak Ridge. 2005.

RadNet Air Monitoring on the Oak Ridge Reservation

Introduction

In the past, air emissions, as a consequence of Department of Energy (DOE) activities on the Oak Ridge Reservation (ORR), have been believed to be a potential cause of illnesses affecting area residents. While these emissions have substantially decreased over the years with the decommissioning of various processes, concerns have remained that air emissions from current activities may pose a threat to the health of the public and/or the surrounding environment. As a consequence of the above, the Tennessee Department of Environment and Conservation, DOE Oversight Division (the Division) will continue three air-monitoring programs developed to assess the impact of ORR air emissions on the surrounding environment and on the effectiveness of DOE controls and monitoring systems.

The Division's Perimeter and Fugitive Air Monitoring Programs (described in associated plans) will focus on monitoring at exit pathways, diffuse emissions, and sites of special interest (e.g., remedial sites). Division participation in EPA's RadNet Air program will target specific operations (e.g., the High Flux Isotope Reactor & the TSCA Incinerator) and provide verification of State and DOE monitoring, via independent third party analysis.

Methods and Materials

The five RadNet air monitors (three of which were upgraded this year and the other two of which should be upgraded in 2008) will use synthetic fiber filters (ten centimeters in diameter) to collect particulates as air is pulled through the units at approximately 60 cubic meters per hour, which is the same as about 35 cubic feet per minute. The monitors will be operated continuously and the filters will be changed twice weekly (Monday and Thursday) by Division staff. The quantity of radioactivity on each filter will be estimated by staff, using a radiation detector, in accordance with the RadNet Standard Operating Procedure. The filters will then be mailed to EPA's National Air and Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama for analysis. The results received from NAREL will be compared to data collected in the perimeter and fugitive air monitoring programs (to verify the quality of State analysis) and to the Clean Air Act (to assess compliance with applicable standards). Analytical parameters and frequencies for the RadNet Air Monitoring Program are provided in Table 1. The approximate locations of the five RadNet air-monitoring stations are depicted in Figure 1.

Table 1: EPA Analysis of Air Samples Taken in Association with the RadNet Program

ANALYSIS	FREQUENCY
Gross Beta	twice weekly
Gamma Scan	Samples having > 1 pCi/m^3 of gross beta
Plutonium-238, Plutonium-239, Plutonium-240, Uranium-234, Uranium-235, Uranium-238	Semiannually on composite air particulate filters

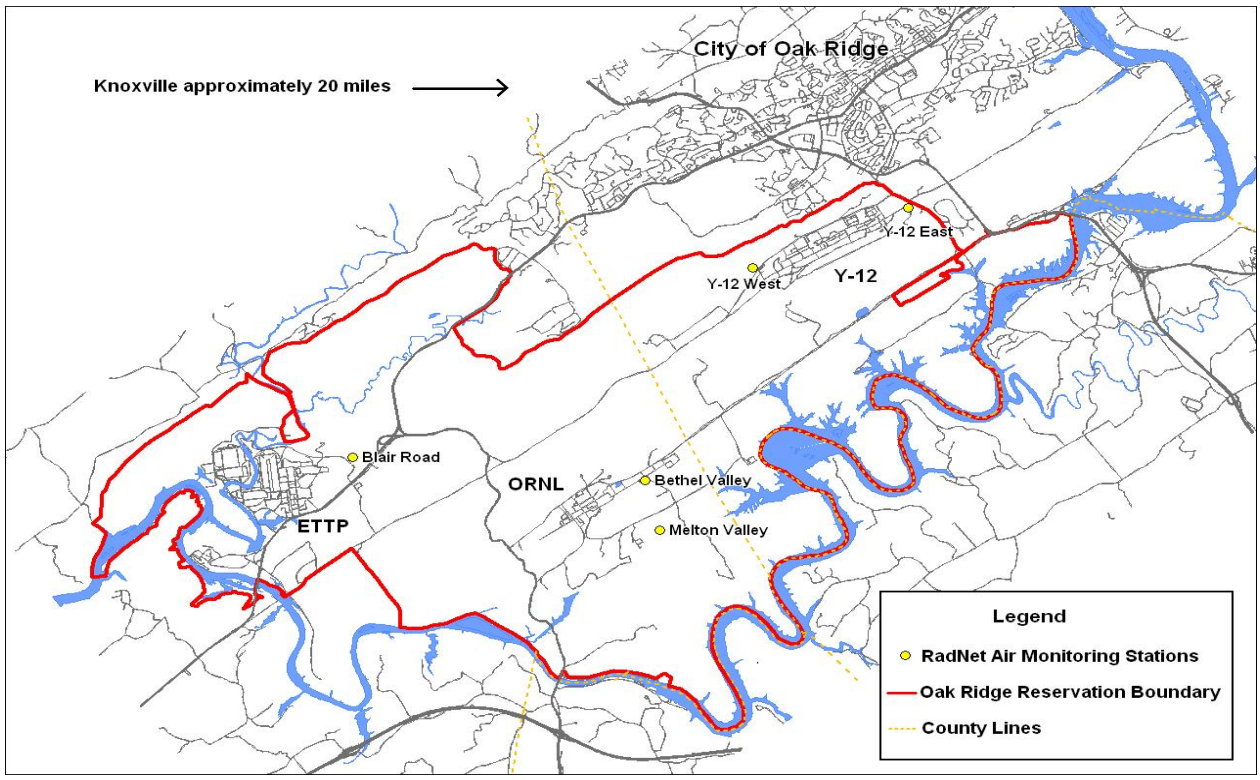

Figure 1: Approximate Locations of Air Stations Monitored in Association with EPA's RadNet Air Program on the Oak Ridge Reservation

References

Environmental Radiation Ambient Monitoring System (ERAMS) Manual, EPA520/5-84-007, 008, 009, Environmental Protection Agency, May 1988.

Environmental Radiation Data Report 123, EPA-402-R-97-004, U.S. Environmental Protection Agency, Data from July - September 2005. http://www.epa.gov/narel/radnet/erd/erd123.pdf

U.S. Environmental Protection Agency. http://oaspub.epa.gov/enviro/erams_query.simple_query (Last updated November 1, 2007)

U.S. Environmental Protection Agency. http://www.epa.gov/narel/radnet/programs.html#air (Last updated August 13, 2007).

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation. Oak Ridge, Tennessee, 2006.

Thomasson, D.A., *Health, Safety, and Security Plan*, Tennessee Department of Environment and Conservation, DOE-Oversight Division. Oak Ridge, Tennessee. 2005.

Monitoring Fugitive Radioactive Air Emission on the Oak Ridge Reservation

Introduction

In 2008, the Tennessee Department of Environment and Conservation DOE Oversight Division (the Division), with the cooperation of the Department of Energy (DOE) and its contractors, will continue monitoring for fugitive radioactive air emissions on and in the vicinity of the Oak Ridge Reservation. This program uses mobile high-volume air samplers to supplement air monitoring performed at fixed locations. The high-volume air monitors, along with more frequent sampling and analysis, provide greater measurement sensitivity and resolution than can be achieved with the low-volume monitors used in the Division's Perimeter Air Program. Monitoring performed with the mobile units will primarily focus on nonpoint sources of air emissions and sites of special interest.

Methods and Materials

The Division will deploy five high-volume air monitors in the program in 2008. One of the monitors will be stationed at Fort Loudoun Dam in Loudon County to collect background data. The other units will be placed at locations where the potential for the release of fugitive/diffuse emissions exists. Two of the samplers are currently positioned to monitor the air around the demolition of buildings at ETTP. Both are used to monitor the K-25 Process Building as well as any other nearby buildings that are being demolished. The third unit has been placed to monitor waste disposal activities at the Environmental Management Waste Management Facility (EMWMF) in Bear Creek Valley. The fourth unit is located at the Oak Ridge National Laboratory (ORNL) near the Corehole 8 remediation site to monitor the excavation of contaminated soils. Other locations under consideration for monitoring include facilities being renovated under the revitalization initiative at ORNL and buildings being demolished at Y-12 as part of its infrastructure reduction program.

The high-volume monitors use 8x10 inch glass fiber filters to collect particulates as air is pulled through the system at a rate of approximately 35 cubic feet per minute. The filters will be collected weekly and shipped to the State of Tennessee's Environmental Laboratory in Nashville, Tennessee, for analysis. As in the past, airflow through the filters will be calibrated quarterly, using a Graseby General Metal Works Variable Resistance Calibration Kit (#G2835).

Analytical parameters will include gross alpha, gross beta, and gamma spectrometry. The results will be compared to background values to determine if releases are occurring. Since the Clean Air Act (CAA) does not provide limits for gross activities, radionuclide specific analysis will be performed where the gross results indicate significant spikes, upward trends, consistently elevated results, and/or exceeded screening levels. The screening levels for gross measurements will be based on CAA limits for uranium-235 for alpha emitters (9.9E-15 uCi/ml above background) and strontium-90 for beta emitters (40.9 E-15 uCi/ml above background). Any gross measurements exceeding these criteria will require isotopic analysis to identify the major radionuclides present in the sample as well as concentration levels for each identified radionuclide. These concentrations will then be used to reassess compliance with the CAA.

References

National Emissions Standards for Hazardous Air Pollutants (NESHAPS), Clean Air Act, Title 40 CFR Part 61, Subpart H. U.S. Environmental Protection Agency, 1994.

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation, Oak Ridge, Tennessee. 2006.

Thomasson, D.A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, Oak Ridge, Tennessee. 2005.

Perimeter Air Monitoring on the Oak Ridge Reservation

Introduction

The Tennessee Department of Environment and Conservation, DOE Oversight Division (the Division), with the cooperation of DOE, will provide radiochemical analysis of air samples taken from twelve low-volume air monitors placed at locations believed to be the most likely pathways for airborne contaminants migrating off the Oak Ridge Reservation (ORR). Data derived from the analyses, along with information generated by the other Division air monitoring programs, will be used to:

1) assess the impact of DOE activities on the public health and environment,
2) identify and characterize unplanned releases,
3) establish trends in air quality, and
4) verify data generated by DOE and its contractors.

Methods and Materials

The twelve air monitors that will be used in the program are owned by DOE. DOE contractors are responsible for their maintenance and calibration. Nine of the units are components of DOE's ORR perimeter air monitoring system. The remaining three monitors were previously used by the Y-12 complex in their perimeter air monitoring program.

Each of the monitors use forty-seven millimeter borosilicate glass fiber filters to collect particulates as air is pulled through the units. The ORR perimeter monitors employ a pump-and-flow controller to maintain airflow through the filters at approximately two standard cubic feet per minute. The Y-12 monitors control airflow with a pump-and-rotometer set to average approximately two standard cubic feet per minute.

Air filters from the monitors will be collected bi-weekly and sent to the State environmental lab in Nashville, Tennessee for radiological analyses. Analysis will include gross alpha and gross beta on the biweekly samples and gamma spectrometry on an annual composite sample from each location. The results will be compared to the background data, to determine if releases appear to be occurring and to the environmental standards provided in the Clean Air Act (Appendix E Table 2 of *Title 40 CFR 61*) to determine if any releases are likely to have exceeded the Clean Air Act dose limit for members of the public (10 mrem/year).

If the preliminary evaluation suggests there is a potential for an unpermitted source, or results exceed the Clean Air Act Standards, and/or practice is inconsistent with the ALARA (As Low As Reasonably Achievable) principle, additional analyses will be performed on the samples to identify the specific radionuclides contributing to the release. The compliance status will also be reevaluated based on the radionuclide specific data. In all cases, the goal will be to maintain releases of radioactive contaminants as low as reasonably achievable (ALARA).

The twelve air monitoring stations in the program are listed in Table 1 and their locations are depicted in Figure 1. Eleven of these stations are located around the perimeter of the ORR and the Y-12 facility. The twelfth site is a background station located near Fort Loudoun Dam in Loudon County.

Table 1: Perimeter Air Monitoring Stations

Station	Location	County
4	Y-12 Perimeter near Portal 2	Anderson
5	Y-12 Perimeter near Building 9212	Anderson
8	Y-12 Perimeter west end	Anderson
35	East Tennessee Technology Park	Roane
37	Bear Creek at Y-12	Roane
38	Westwood Community	Roane
39	Cesium Fields at Oak Ridge National Laboratory Services	Roane
40	Y-12 East	Anderson
42	East Tennessee Technology Park off Blair Road	Roane
46	Scarboro Community	Anderson
48	Deer Check Station on Bethel Valley Road	Anderson
52	Fort Loudoun Dam (Background Station)	Loudon

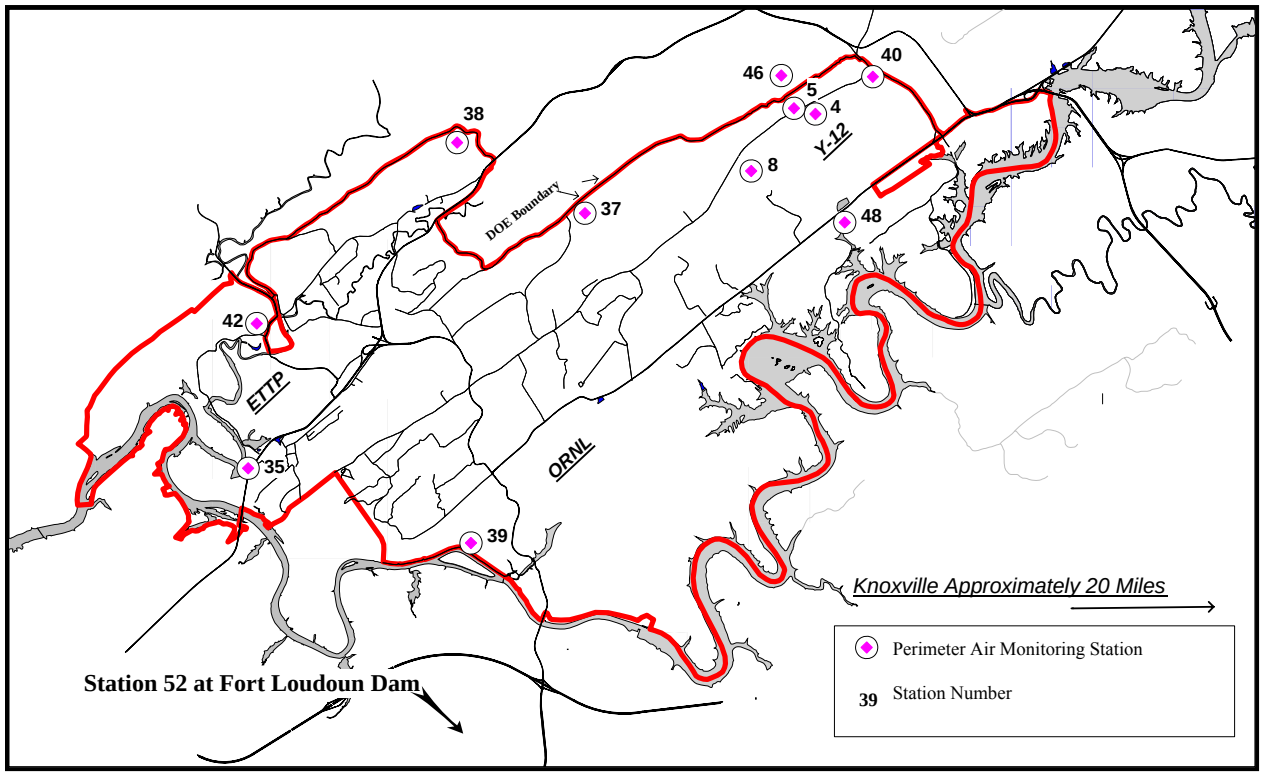

Figure 1: Approximate Location of Oak Ridge Reservation and Y-12 Perimeter Air Monitoring Stations

References

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation, Oak Ridge, Tennessee. 2006.

Thomasson, D.A. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, Oak Ridge, Tennessee. 2005.

RadNet Precipitation Monitoring on the Oak Ridge Reservation

Introduction

Precipitation monitoring was added to the RadNet program on the Oak Ridge Reservation in 2005. The project measures radioactive contaminants that are washed out of the atmosphere and carried to the earth's surface by precipitation. There are no standards that apply directly to contaminants in precipitation, but the data provide an indication of the presence of radioactive materials that may not be evident in the particulate samples collected by the Division's air monitors. EPA has provided two samplers to date, and a third will be provided for 2008. All precipitation samplers are co-located next to RadNet air monitoring locations (described in an associated report) on the Oak Ridge Reservation.

One of the radioactive contaminants of concern in the atmosphere above the Reservation is tritium. Small amounts of this radionuclide are produced naturally, but the isotope is also released as water vapor in reactor effluents and from evapotransporation associated with buried wastes. In light of the above, one precipitation monitor provided by EPA was placed at an existing RadNet air station near ORNL's High Flux Isotope Reactor and the SWSA 5 (solid waste storage area) burial grounds, the major source area for tritium on the reservation. Data received to date have been among the higher values reported for the RadNet monitoring stations across the nation (Figure 1). It should be noted, however, that Oak Ridge was the only station located near nuclear sources at the time. Another precipitation monitor was placed in April 2007 near the TSCA Incinerator and is co-located with the Blair Road RadNet air station, east of ETTP. The third and final precipitation station will be co-located with the RadNet station east of Y-12. This station will be used to monitor Y-12 as well as provide an indication of if any tritium is traveling towards the city of Oak Ridge from Melton Valley, where tritium levels are high.

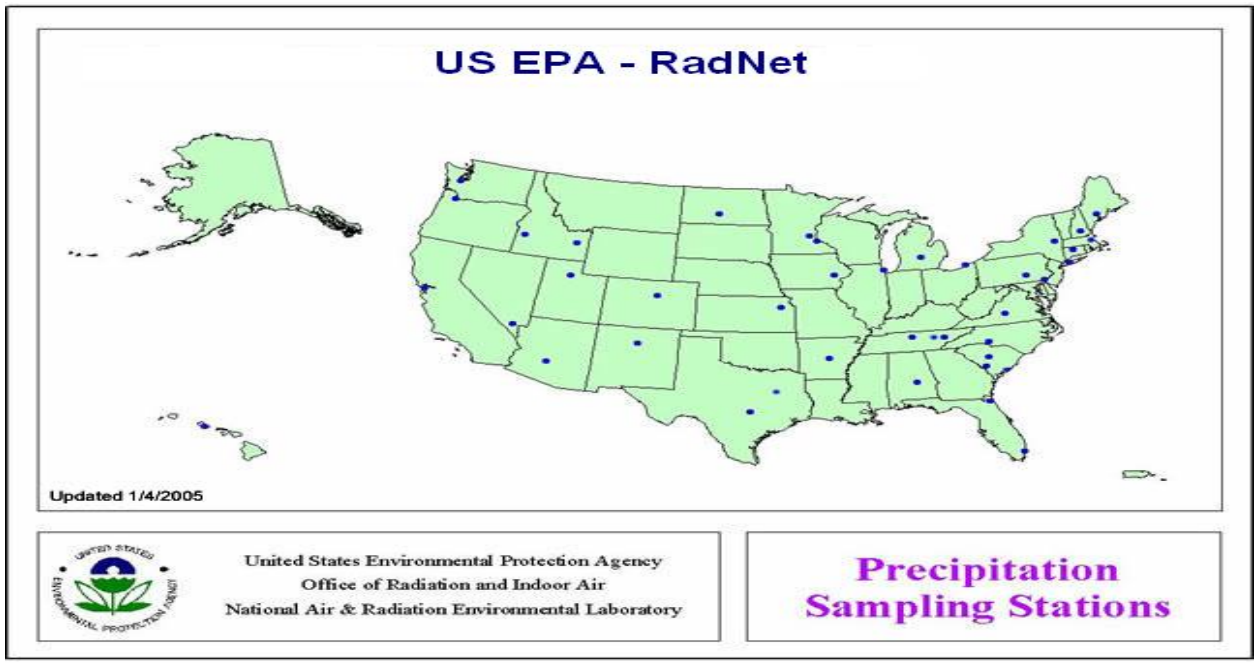

Figure 1: EPA RadNet Precipitation Monitoring Stations

Methods and Materials

The precipitation monitors provided by EPA's RadNet Program will be used to collect samples for the program. Each monitor will collect precipitation that falls on a 0.5 square meter fiberglass collector which drains into a five-gallon plastic collection bucket. Each station will be checked twice a week and a sample will be taken from the bucket (using a four-liter cubitainer) when a minimum of one liter of precipitation has accumulated in the collection bucket. The sample will then be processed as specified in *Environmental Radiation Ambient Monitoring System (ERAMS) Manual* (U.S. EPA, 1988) and shipped to EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama for analysis (Table 1). Results from these analyses will be provided to the Division and posted on EPA's RadNet website (http://www.epa.gov/narel/radnet) both as a quarterly PDF (http://www.epa.gov/narel/radnet/erdonline.html) as well as a searchable database (http://oaspub.epa.gov/enviro/erams_query.simple_query). The data will be used to identify anomalies (e.g., unknown contaminants), to assess the significance of precipitation in contaminant pathways, to evaluate associated control measures, and to appraise conditions on the Oak Ridge Reservation compared to other locations in the RadNet program.

Table 1: EPA Analysis of Precipitation Samples Taken in Association with the RadNet Program

ANALYSIS	FREQUENCY
Gross Beta	Monthly from composite samples
Gamma Scan	Monthly composite samples having > 1 pCi/m^3 of gross beta
Tritium	Monthly from composite samples

References

Environmental Radiation Ambient Monitoring System (ERAMS) Manual, EPA 520/5-84-007, 008, 009, U.S. Environmental Protection Agency, May, 1988.

Environmental Radiation Data Report 123, EPA-402-R-97-004, U.S. Environmental Protection Agency, data from July - September 2005. http://www.epa.gov/narel/radnet/erd/erd123.pdf

U.S. Environmental Protection Agency. http://oaspub.epa.gov/enviro/erams_query.simple_query (Last updated November 1, 2007).

U.S. Environmental Protection Agency. http://www.epa.gov/narel/radnet/programs.html#air (Last updated August 13, 2007).

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation. Oak Ridge, Tennessee. 2006.

Thomasson, D.A. *Health, Safety, and Security Plan,* Tennessee Department of Environment and Conservation, DOE-Oversight Division. Oak Ridge, Tennessee. 2005.

This page intentionally left blank.

BIOLOGICAL/FISH AND WILDLIFE

Threatened & Endangered Species Monitoring

Introduction

Vascular plant field surveys on portions of the Oak Ridge Reservation (ORR) were initiated during mid-2003 by Division staff. For example, vascular plant surveys have been conducted on sections of the East Black Oak Ridge Conservation Easement (East BORCE). Considerable field reconnaissance work remains to be completed in 2008 on the West BORCE and other parcels of the ORR associated with CERCLA remediation activities that may require field evaluation of threatened and endangered plant species (T & E species). Recently, the West BORCE area was opened (October 2007) as a new greenway trail (Dyllis Orchard trail) creating opportunity for additional field assessments of T & E species.

Major functions and focus of the project include: 1) provide botanical oversight and field support to the TDEC Division of Natural Heritage as needed relating to ORR issues, especially T & E species, 2) inventory and map the botanical diversity that exists on the ORR, 3) independently monitor and verify biological survey information provided by DOE, making sure that CERCLA ARARs are honored, 4) protect plants and TDEC-designated natural areas that represent biological diversity on the ORR, 5) provide field oversight during DOE subcontractor vascular plant surveys on ORR projects (i.e., road construction projects, land transfers, etc.), and 6) identify areas of the ORR infested with exotic pest plants (Drake et al. 2002, TEPPC 2002).

This project will incorporate the Division's oversight role of environmental surveillance and monitoring (TDEC 2006). Several federal and state laws support this effort. The federal Endangered Species Act of 1973 (ESA), as amended, provides for the inventory, listing, and protection of species in danger of becoming extinct and/or extirpated, and conservation of the habitats on which such species thrive. The National Environmental Policy Act (NEPA), requires that federally-funded projects avoid or mitigate impacts to listed species. The Tennessee Rare Plant Protection and Conservation Act of 1985 (Tennessee Code Annotated Title 11-26, Sects. 201-214), provides for a biodiversity inventory and establishes the State list of endangered, threatened, and special concern taxa. National Resource Damage Assessments (NRDA), as directed by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by SARA (Superfund Amendments and Reauthorization Act of 1986), relates to damages to natural resources on the ORR.

Methods and Materials

Monitoring of vascular plants on the ORR by Division staff will follow a modified version of the methods and guidance outlined in Washington-Allen et al. (1995) and Awl et al. (1996). Additionally, field methods for documentation of pteridophytes (ferns and fern allies) will follow the field protocols of the All Taxa Biodiversity Inventory fern forays (ATBI 2007) project in the Great Smoky Mountains National Park. Field mapping of native and invasive plant species will

utilize field stations (50 foot diameter mini-plots) at pre-selected intervals (i.e., grid patterns, traverses, etc.) based on specific reconnaissance projects. Unusual or rare plants will be located and mapped, if found, between these intervals. Sometimes, spot locations of plant taxa may be recorded while on water or sediment sampling field trips. Generally, field biodiversity inventories will begin with existing roads and trails, then transects will be walked cross-country (similar to a "timber cruise") in generally north-south, east-west traverses to complete a grid pattern of coverage over the parcel.

Habitats such as small drainage ravines, floodplains, wetlands, watersheds, sub-watersheds, sinkholes, cedar barrens, rock outcroppings, cliffs, springs, caves, etc. will be field surveyed for plant taxa. Field surveys are designed to locate and identify T & E plant species, invasive plant species, aquatic and wetland taxa.

Each field station (mini-plot) will be mapped and located using a global positioning system (GPS) hand-held field unit (Garmin® Etrex). Each field station will be defined as a 50-foot circle from center point or circumference. Plant taxa will be organized and compartmentalized as canopy, subcanopy, shrub, herbaceous, and groundcover layers. Digital camera images will be made at most field sites to record and document plant taxa. Additionally, the boundaries of the pine deadfall areas (pine-beetle devastated areas) will be mapped whenever possible in the field. These sites may become important ecological study areas to determine if native climax species or invasives will re-establish here.

Terrestrial plant species may be collected for preservation as herbarium specimens (vouchers). The sample will be collected as much as possible with either flower or fruit, then pressed and dried, and mounted on herbarium paper with appropriate identification labels. These are quite useful for training purposes but, more importantly, to ensure proper documentation and confirmation of plant species (especially rare species) encountered in the field. Care will be taken while collecting plant specimens so as not to destroy or damage a rare plant colony.

Vascular plant identifications will require the use of the following sources and taxonomic keys: Radford et al. (1968), Prescott (1980), Cobb (1984), Lellinger (1985), Wofford (1989), Gleason & Cronquist (1991), Chester et al. (1993), Chester et al. (1997), Carman (2001), Wofford & Chester (2002), University of Tennessee Herbarium (2007), and Weakley (2007).

Field data sheets (survey logs) will be recorded for each survey station and later placed in a database for inclusion in the environmental monitoring report. Maps will be prepared with available GIS software to illustrate locations of all field stations with plant data, geologic features and other pertinent biological habitat and field data.

Field monitoring methods and health and safety procedures will follow the guidelines in the Division's *Health, Safety, and Security Plan* (Thomasson 2005).

References

ATBI. *All Taxa Biodiversity Inventory/Discover Life in America*. Great Smoky Mountains National Park. http://www.dlia.org/atbi/methods/fern_foray.shtml 2007.

Awl, D. J. *Survey of Protected Vascular Plants on the Oak Ridge Reservation, Oak Ridge, Tennessee*. ORNL-Environmental Restoration Division. Lockheed Martin Energy Systems. ES/ER/TM-194. June 1996.

Carman, Jack. *Wildflowers of Tennessee*. Highland Rim Press. Tullahoma, TN. 2001.

Chester, E. W., B. E. Wofford, R. Kral, H. R. DeSelm, & A. M. Evans. *Atlas of Tennessee Vascular Plants* Volume 1: Pteridophytes, Gymnosperms, Angiosperms, & Monocots. Miscellaneous Publication No. 9. The Center for Field Biology. Austin Peay State University. Clarksville, TN. 1993.

Chester, E. W., B. E. Wofford, & R. Kral. *Atlas of Tennessee Vascular Plants* Volume 2: Dicots. Miscellaneous Publication No. 13. The Center for Field Biology. Austin Peay State University. Clarksville, TN. 1993.

Cobb, B. *Peterson Field Guide: Ferns.* Houghton Mifflin Company. New York, NY. 1984.

Gleason, H.A. & Cronquist, A. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada.* The New York Botanical Garden, Bronx, New York. 1991.

Drake, S. J., J. F. Weltzin, & P. D. Parr. *Assessment of Nonnative Invasive Plants in the DOE Oak Ridge National Environmental Research Park.* ORNL/TM-2001/113. Environmental Sciences Division. Oak Ridge National Laboratory. Oak Ridge, TN. 2002.

Lellinger, D. B. *A Field Manual of the Ferns and Fern Allies of the United States and Canada.* Smithsonian Institution Press. Washington, D.C. 1985.

Prescott, G. W. *How to Know the Aquatic Plants*. 2nd edition. WCB McGraw-Hill Publishers. Boston, MA, New York, NY, San Francisco, CA, St. Louis, MO. 1980.

Radford, A. R., H. E. Ahles, and C. R. Bell. *Manual of the Vascular Flora of the Blue Ridge*. The University of North Carolina Press. Chapel Hill, North Carolina. 1968.

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement. Agreement Between the Department of Energy and the State of Tennessee.* Oak Ridge, Tennessee. 2006.

Tennessee Exotic Pest Plant Council (TEPPC). *Invasive Exotic Pest Plants in Tennessee*. Journal of the Tennessee Academy of Science 77(2): 45-48. April 2002.

University of Tennessee. University of Tennessee Herbarium Webpage. Department of Ecology and Evolutionary Biology. Knoxville, Tennessee. 2007. http://tenn.bio.utk.edu/vascular

Washington-Allen, R. A., T. L. Ashwood, S. W. Christensen, H. Offerman, and P. Scarbrough-Luther. *Terrestrial Mapping of the Oak Ridge Reservation: Phase 1.* ES/ER/TM-152. Environmental Sciences Division. Oak Ridge National Laboratory. Oak Ridge, TN. 1995.

Weakley, A. S. *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas.* Working Draft. North Carolina Botanical Garden. University of North Carolina. Chapel Hill, NC. 2007.

Wofford, B. E. *Guide to the Vascular Plants of the Blue Ridge*. The University of Georgia Press. Athens, Georgia. 1989.

Wofford, B. E. and E. W. Chester. *Guide to the Trees, Shrubs, and Woody Vines of Tennessee*. The University of Tennessee Press. Knoxville, Tennessee. 2002.

Thomasson, D. A., *Health, Safety, and Security Plan.* Tennessee Department of Environment & Conservation, DOE-Oversight Division. Oak Ridge, TN. 2005.

Benthic Macroinvertebrate Monitoring

Project Description

The objective of this monitoring program is to perform biological monitoring on streams affected by activities and practices on the Oak Ridge Reservation (ORR). Monitoring methods are outlined in the *State of Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control (WPC) Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys* (November 2003, Revised October 2006) will be used.

Introduction

Because benthic macroinvertebrates are relatively sedentary and long-lived, they are excellent indicators of the "overall health" of an aquatic system. In systems where the source of the toxicant is non-point (e.g. runoff or seeps) or where the combined effects of pollutants in a complex effluent exceed individual toxicity (synergism), benthic macroinvertebrate communities may be one of the only means of evaluation.

Benthic macroinvertebrates are collected from various ORR streams and analyzed to independently assess the "overall health" of the aquatic environments and to measure the degree of impact from past and present DOE operations. The Division conducts annual semi-quantitative biomonitoring on the following ORR streams: Bear Creek, Mitchell Branch, White Oak Creek, Melton Branch, and East Fork Poplar Creek. Benthic samples are also collected from Clear Creek near Norris Dam which serves as an ecoregion reference site for all ORR test sites. Samples will be collected in Upper Scarboro Creek near the UT Arboretum and two other sites, possibly Raccoon Creek and Grassy Creek, for qualitative analysis at no cost.

Surface water samples will be collected semi-annually at most semi-quantitative sites and will compliment the macroinvertebrate sampling. Water samples will be transported to Laboratory Services in Knoxville and analyzed for bacteria, nitrates, hardness, metals, mercury, and radionuclide constituents. In addition, sulfates will be analyzed in East Fork Poplar Creek and Hinds Creek. Hexavalent chromium will be analyzed in Mitchell Branch. EPA-approved methods will be used for the collection of the water samples. All work associated with this program will be in compliance with the Division's *Health, Safety, and Security Plan.*

Methods and Materials

Benthic macroinvertebrate samples will be collected and processed following TDEC Water Pollution Control (WPC) standard operating procedures (SOP). The semi-quantitative Riffle Kick (SQKICK) collection technique for single habitat analysis will be used. This test method involves standing in a body of water, kicking up sediment and catching the suspended organisms in a kick net. A riffle kick is done in relatively fast-moving water and a run kick in slower-moving water. Another test is the undercut bank jab, done by sampling the sediment below water level in an area that is overhung by brush.

Samples will be collected from two riffles at each site. Both samples will be combined and transferred into one sample container. The container will be labeled internally and externally with site-specific information and stored in the TDEC DOE-O laboratory for future processing. Standard methods will be altered when sampling lower White Oak Creek due to the presence of radioactive contamination in the stream sediment. The two kick samples will be combined in a five-gallon bucket, creek water will be added and the sample swirled to suspend the lighter material (invertebrates), which will then be poured through a sieve. This process will be repeated five times, collecting the majority of organisms. Any material not used will be returned to the creek.

Once collections have been made at all sites, the semi-quantitative samples will be transported to Laboratory Services in Nashville for processing. Laboratory Services sample analyses will include the identification and enumeration of the benthic macroinvertebrates. Using the raw benthic data from the semi-quantitative sub-samples, a numerical value will be generated for seven biometrics. These metrics include (1) EPT (*Ephemeroptera, Plecoptera, and Trichoptera*) richness, (2) taxa richness, (3) percent OC (oligochaetes and chironomids), (4) percent EPT (EPT abundance), (5) NCBI (North Carolina Biotic Index), (6) percent nutrient tolerant, and (7) percent clingers (contribution of organisms that build fixed retreats or that have adapted to attach to surfaces in flowing waters). After values have been calculated for the metrics, a score of 0, 2, 4, or 6 is assigned to each metric based on comparison to the ecoregion reference database. The seven scores are totaled and the site's biological condition is determined. Metric equations and the biocriteria used to determine biological condition can be obtained by referring to the TDEC WPC SOP.

Sampling Locations in Kilometers (mile equivalents) for RBP III Semi-Quantitative Sites:

East Fork Poplar Creek: EFK 25.1 (15.6), EFK 24.4 (15.2), EFK 23.4 (14.5), EFK 13.8 (8.6), and EFK 6.3 (3.9). Reference site: Hinds Creek HCK 20.6 (12.8).

Bear Creek: BCK 12.3 (7.6) and BCK 9.6 (6.0). Reference site: Mill Branch MBK 1.6 (1.0).

Mitchell Branch Creek: MIK 0.71 (0.44) and MIK 0.45 (0.28). Reference sites: MIK 1.43 (0.89).

White Oak Creek: WCK 2.3 (1.4), WCK 3.4 (2.1), and WCK 3.9 (2.4). Reference site: WCK 6.8 (4.2).

Melton Branch: MEK 0.3 (0.2)

Clear Creek: CCK 1.45 (ecoregion reference site).

Weather permitting, field sampling will be completed within a two-week time span in April or May.

The qualitative samples will be collected using the Biorecon (reconnaissance/screening) method. One to four productive habitats (e.g., riffles, runs, pools, and undercut banks) will be selected that comprise greater than 5% of the stable habitat in the sampling reach. The selected habitats will be divided into four portions based on percent contribution. For example, if the habitats consist of 50% riffle, 25% run, and 25% undercut bank, the sample would be comprised of two riffle kicks, one run kick, and one undercut bank jab. The four sub-samples will be combined into one site sample. Each habitat will be sampled over a 0.5-meter sampling area using a triangular net. The combined sample will be examined in the DOE-O laboratory and

appropriate information will be recorded on the Biorecon sheet. Using the raw benthic data, a numerical value will be generated for three qualitative biometrics: 1) EPT richness, 2) taxa richness, and 3) intolerant taxa (those organisms having NCBI values between 0.00 and 3.00).

After values have been calculated for the metrics, a score of 1, 3, or 5 is assigned to each metric based on ranges at the scientific family level. The three scores will be totaled and the site assessment determined. The biocriteria used to determine biological condition can be obtained by referring to the TDEC WPC SOP.

Table 1: List of Analytes for Surface Water Samples

E. Coli	arsenic
Enterrococcus	cadmium
nitrogen, NO_2, NO_3, & ammonia	chromium hexavalent chromium (Mitchell Branch)
total Kjeldahl nitrogen	copper
total phosphorus	iron
dissolved residue	lead
suspended residue	manganese
hardness, total, as $CaCO_3$	zinc
sulfates (East Fork Poplar Creek)	gross alpha gross beta
mercury	gamma spec

References

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region IV, 960 College Station Road, Athens, Georgia. 1996.

Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys, Tennessee Department of Environment and Conservation, Division of Water Pollution Control, November 2003, Revised October 2006.

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation, Oak Ridge, Tennessee. 2006.

Thomasson, D.A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Diatom (Periphyton) Environmental Monitoring Plan

Introduction

During 2008, the Division will continue efforts to characterize diatom assemblages for water quality assessment of impacted watershed streams on the Oak Ridge Reservation (ORR). The goal of this monitoring program is to assess impacts of anthropogenic stress on benthic algae and diatoms (periphyton) in streams affected by activities and practices on the ORR. Methodology for the project will follow periphyton survey as outlined in the Tennessee Department of Environment and Conservation (TDEC) Division of Water Pollution Control (WPC) *Regional Characterization of Streams in Tennessee with Emphasis on Diurnal Dissolved Oxygen, Nutrients, Habitat, Geomorphology and Macroinvertebrates* (Arnwine et al. 2005). Additional periphyton sampling and laboratory protocols developed by Porter et al. (1993), Barbour et al. (1999), KDOW (2002) and Moulton II et al. (2002) will be applied to the project. Periphyton samples will be collected quarterly from natural substrates in three ORR watersheds. The main objectives of the project include: 1) determine diatom composition and abundance of the periphyton community in each affected ORR watershed, 2) establish a baseline of diatom taxa that respond to pollution on the ORR, 3) investigate longitudinal variation in diatom populations downstream from DOE pollution sources, 4) determine abiotic variables driving diatom community responses, and 5) support the Division's comprehensive and integrated monitoring programs including concurrent macroinvertebrate monitoring (TDEC 2006).

Industrial and agricultural pollution can have significant impacts on water quality which can influence aquatic food web structuring (Vitousek et al. 1997, Brennan & Withgott 2004). Because periphyton assemblages are attached to natural substrates, the benthic algae community responds to biological and physiochemical disturbances that occur longitudinally in a stream reach during algal colonization (Medley & Clements 1998, Stevenson & Bahls 1999). Benthic algae and diatoms are primary producers in the food web and the literature suggests they are excellent biological indicators for many types of pollution in aquatic systems (Dixit et al. 1992, Kelly et al. 1995, Stevenson & Pan 1999). Periphyton communities contain many diatom taxa with individual tolerances to anthropogenic stressors such as elevated concentrations of heavy metals and high nutrient loads (Deniseger et al. 1986, Genter et al.1988, Takamura et al. 1989, Dixit et al. 1992, St-Cyr 1997, Medley & Clements 1998).

Periphyton is a complex matrix of mostly benthic algae (including diatoms), heterotrophic microbes, bacteria, fungi, and protozoa attached to submerged substrates in almost all aquatic ecosystems. Diatoms, a major component of periphyton, are unicellular microflora (photosynthetic protists with chloroplasts) and belong to the phylum *Chrysophyta* (sub-phylum *Bacillariophyceae*). Diatoms colonize nearly every available aquatic habitat and are unique in that they form a silicified and overlapping frustule that fit together similar to a petri dish and its cover.

Pollution (anthropogenic stress) of an aquatic system comes in many forms including organic and inorganic chemical, heavy metal, radiological contamination, microbiological, and those of a physical nature such as temperature, light, turbidity, and dissolved oxygen. Sources of pollution

include industrial releases, agricultural runoff, and residential discharges. The complexity of modern day pollution complicates the clear delineation between tolerant, resistant, and sensitive species of diatoms (Patrick 1973). However, by examining diatom community assemblages, and determination of shifts in species composition and structure over time, impaired water quality trends can be detected (Patrick 1973).

Methods and Materials

Periphyton will be sampled at fourteen stream riffle zone sites in 2008 within the East Fork Poplar Creek (EFK), Bear Creek (BCK), Mitchell Branch (MIK) and associated reference sites. Specific site locations in stream kilometers (miles) and respective reference sites include:

- *East Fork Poplar Creek:* EFK 23.4 (14.5), EFK 13.8 (8.6), and EFK 6.3 (3.9). Reference sites: Brushy Fork / BFK 7.6 (4.7) and Hinds Creek / HCK 20.6 (12.8)
- *Bear Creek:* BCK 12.3 (7.6), BCK 9.6 (5.9), BCK 4.55 (2.8), and BCK 0.63 (3.9). Reference site: Mill Branch / MBK 1.6 (1.0)
- *Mitchell Branch Creek*: MIK 0.71 (0.44) and MIK 0.45 (0.28). Reference sites: MIK 1.43 (0.89).
- *Clear Creek*: CCK 1.45 (ecoregion reference site).

Division staff will collect benthic algae samples from natural substrates (i.e., stream cobbles and sediments, small rocks). Water temperature, conductivity, total dissolved oxygen and pH measurements will also be determined during each sampling event (Horiba U-10® Water Quality Checker) and recorded in the field logbook. Additional real-time field data may be collected including stream flow velocity, water depths, canopy cover, and photosynthetic light data.

In the field, three or four submerged rocks (size ~10-15 cm² each) with attached periphyton will be randomly selected at each stream site and later composited into one sample (W. R. Hill, *in* Adams et al. 1998, Barbour et al. 1999, Moulton II et al. 2002, Ponader & Charles 2005). Rocks will be placed in labeled, double-bagged one-gallon ZipLok® baggies and placed in an ice chest for transport. Volumetric determinations of algal biomass removed from the rocks will be determined by the aluminum foil gravimetric method (Carr et al. 2005, Ponader & Charles 2005).

Samples will be collected quarterly at nine impaired and five reference sites while collecting periphyton (concurrent project). During each sampling event, water quality data will be gathered with the Horiba U-10® Water Quality Checker (pH, conductivity, temperature, dissolved oxygen, & turbidity). A concurrent project will collect surface water samples twice-a-year at these sites and will compliment the testate amoebae sampling. Water samples will be transported to Laboratory Services in Knoxville and analyzed for nitrates, metals and radionuclide constituents. All work associated with this program will be in compliance with the Division's *Health, Safety, and Security Plan* (Thomasson 2005).

Colonized benthic algae is removed from the three rock samples by brushing one flat surface of each rock until all algae is removed. Then a composite of the algal slurry is collected in a clean

laboratory pan. The slurry is then mixed in a blender at low speed and the sample divided into two splits (one preserved with Lugol's solution/one un-preserved for live material). Each split is placed in labeled beakers and allowed to settle overnight in laboratory hood. Excess water is decanted and the remaining end product should be ~50 ml periphyton slurry. Both splits will be stored at 4° C in the Division laboratory. Laboratory method is modified from several protocols including W. R. Hill, *in* Adams et al. (1998), Stevenson & Bahls (1999), KDOW (2002), Moulton II et al. (2002), Carr et al. (2005), and Ponader & Charles (2005).

Replicate periphyton samples will be collected in every tenth stream sample for Quality Assurance/Quality Control (QA/QC) purposes. Percent Community Similarity (PCS) will be computed between the study site sample and the QC sample for that site. PCS will assess the similarity between the estimated densities of diatom species shared in both samples. These laboratory QA/QC procedures adhere to EPA methods for assessing periphyton communities in lotic systems (EPA 1998).

All samples will be examined in-house by Division staff using the Olympus® BH-1stereo microscope, the TrueVision® XSP15B stereo microscope (w/ PupilCam® digital camera), and the Zeiss® inverted microscope. Identifications will be determined on both fresh sample material and cleaned diatoms. To clean diatoms, they must be boiled in an acid bath to clear their frustules of organic and intercellular material (Hasle & Fryxell 1970, Hill & Boston 1991, Sabater et al. 2002, KDOW 2002, Hill 2004). The cell wall structure, ornamentation, size, and shape of siliceous frustules are the main diagnostic characters for taxonomic keying of diatom taxa (Stoermer and Smol 1999). Taxonomic identification sources will include: Smith (1950), Patrick & Reimer (1966, 1975), Prescott (1978), and Wehr & Sheath (2003).

Enumeration of diatom cells in each sample will involve examining 2.45 ml of sample slurry in a settling chamber using the Zeiss® inverted microscope. For consistency, at least 10 microscope FOVs (fields-of-view) will be counted to obtain a cell count of +500, or continue counting FOV until 500 cells are determined per sample. During enumeration, diatom taxa counts will be recorded on laboratory bench sheets and organized by genus. Non-diatom taxa (e.g., filamentous green algae, desmids, dinoflagellates) will also be recorded and counted. Periphyton samples with very low biomass may require counting up to a maximum of 100 FOV. The laboratory method for counting diatoms in microscope slides will follow the methods of Hill & Boston (1991), Kelly & Whitton (1995), Stevenson & Bahls (1999), KDOW (2002) and Hill (2004).

Digital microscopic images of diatom taxa will be routinely photographed for taxonomic archival records. If possible, every six months, one periphyton sample from each site will be sent to an outside contractor for taxonomic QA/QC purposes. The data and information generated by this project will be used to meet the objectives as defined in the introduction and to form a database for calculating the diatom metrics.

Metrics

Analysis of the data collected in 2008 will include a measure of species richness, density, and diversity among the community species for each site. Kentucky has an excellent and well established diatom monitoring program (KDOW 2002) that will be modified and utilized for this

monitoring project. The Diatom Bioassessment Index (DBI, KDOW 2002) is a multi-metric index that uses six diatom community structure metrics. It is intrinsically designed to be sensitive to nutrient enrichment, as well as other pollutants including sedimentation, salinity, acidity, and metals. Diatom indicators of environmental conditions can be more precise than one-time sampling and assessments of water chemistry. The following is a brief description of these DBI metrics.

- Total Number of Diatom Taxa (TNDT) = total number of taxa identified (those counted & those showing up on the scan of the slide) and is an estimate of diatom taxa richness.
- Shannon Diversity = index to characterize species diversity (species proportion for all species in a particular ecosystem, e.g., EFPC).
- Pollution Tolerance Index (PTI) = each taxa is assigned a tolerance value based on their tolerance to increased pollution; tolerance values range from 1 (most tolerant) to 4 (most sensitive). The tolerance values are derived from Lange-Bertalot (1979).
- *Cymbella* Group Richness (CGR) = Total number of taxa from the following genera: *Cymbella, Cymbopleura, Encyonema, Encyonemopsis, Navicella, Pseudoencyonema*, & *Reimeria.*
- *Fragilaria* Group Richness (FGR) = Total number of taxa from the following genera: *Ctenophora, Fragilaria, Fragilariforma, Pseudostaurosira, Punctastriata, Stauroforma, Staurosira, Staurosirella, Synedra*, & *Tabularia*
- % *Navicula, Nitzschia, Sururella* (%NNS) = The sum of the relative abundances of all *Navicula, Nitzschia*, & *Sururella* taxa.

The six DBI indicators are then used to obtain a score between one and five for each monitoring site. Diatom taxa can infer stressors involved in lowering the biological integrity of a site. For each assemblage, a rating (excellent-very poor) is derived from each index score. A numeric score representing stream integrity is then assigned based upon the narrative rating (5 = excellent and 1 = very poor).

References

Adams, S. M., T. W. Beaty, C. C. Brandt, D. S. Cicerone, S. W. Christensen, M. S. Greeley, Jr., W. R. Hill, L. A. Kszos, J. F. McCarthy, M. J. Peterson, M. G. Ryon, J. G. Smith, G. R. Southworth, A. J. Stewart, & L. F. Wicker. *Biological Monitoring Program for East Fork Poplar Creek.* YTS-1194 (Rev.25). Oak Ridge National Laboratory, Environmental Sciences Division. Oak Ridge, TN. 1998.

Arnwine, D. H., R. R. James, and K. J. Sparks. *Regional Characterization of Streams in Tennessee with Emphasis on Diurnal Dissolved Oxygen, Nutrients, Habitat, Geomorphology and Macroinvertebrates*. Tennessee Department of Environment and Conservation. Division of Water Pollution Control. Nashville, TN. September 2005.

Bahls, L. L. *Periphyton Bioassessment Methods for Montana Streams*. Department of Health and Environmental Sciences, Water Quality Bureau, Helena, MT. 1999.

Barbour, M.T., J. Gerritsen, B. D. Snyder, & J. B. Stribling. *Rapid Bioassessment for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish.* Second Edition. EPA 841-B-99-002. U. S. Environmental Protection Agency. Office of Water. Washington, D.C. 1999.

Brennan, S. R., and J. H. Withgott. *Environment: The Science Behind the Stories*. Pearson/Benjamin Cummings Publishers, San Francisco, California. 2004.

Carr, G. M., A, Morin, & P. A. Chambers. *Bacteria and Algae in Stream Periphyton Along a Nutrient Gradient.* Freshwater Biology 50:1337-1350. 2005.

Deniseger, J., A. Austin, and W. P. Lucey. *Periphyton Communities in a Pristine Mountain Stream Above and Below Heavy Metal Mining Operations*. Freshwater Biology 16:209-218. 1986a.

Dixit, S. S., J. P. Smol, J. C. Kingston, and D. F. Charles. *Diatoms: Powerful Indicators of Environmental Change.* Environmental Science Technology 26:23-33. 1992.

Genter, R. B., D. S. Cherry, E. P. Smith, and J. Cairns, Jr. *Attached-algal Abundance Altered by Individual and Combined Treatments of Zinc and pH.* Environmental Toxicology and Chemistry 7:723-733. 1988.

Hasle, G. R. and G. R. Fryxell. *Diatoms: Cleaning and Mounting for (KMnO2) Light and Electron Microscopy.* Trans. American Microscopy Society 89:469-481. 1970.

Hill, W. R., and H. L. Boston. *Community Development Alters Photosynthesis-irradiance Relations in Stream Periphyton.* Limnology and Oceanography 36:1375-1389. 1991.

Hill, W. R. *Periphyton Sampling Procedures*. Personal communication. 2004.

Kelly, M. G., C. J. Penney, and B. A. Whitton. *Comparative Performance of Benthic Diatom Indices to Assess River Water Quality*. Hydrobiologia 302: 179-188. 1995.

Kentucky Department of Water (KDOW). *Methods for Assessing Biological Integrity of Surface Waters of Kentucky.* Natural Resources and Environmental Protection Cabinet. Kentucky Department of Environmental Protection. Division of Water. Water Quality Branch. Frankfort, KY. July 2002.

Medley, C. N., & W. H. Clements. *Responses of Diatom Communities to Heavy Metals in Streams: The Influence of Longitudinal Variation*. "Ecological Applications", 8(3), 1998, pp. 631-644, Ecological Society of America. Dept. of Fishery & Wildlife Biology, Colorado State University, Fort Collins, CO. 1998.

Moulton II, S. R., J. G. Kennen, R. M. Goldstein and J. A. Hambrook. *Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities as Part of the National Water-Quality Assessment Program.* Department of the Interior-U. S. Geological Survey. Open-File Report 02-150. Reston, VA. 2002.

Patrick, R., and C. W. Reimer. *The Diatoms of the United States, Exclusive of Alaska and Hawaii*, Volume 1. Academy of Natural Sciences Monograph Number 13. Philadelphia, Pennsylvania. 1966.

Patrick, R. *Use of Algae, Especially Diatoms, in the Assessment of Water Quality*, Biological Methods for the Assessment of Water Quality (Edited by Cairns, J. and Dichson, K.I.), pp. 76-95. ASTM, Philadelphia. 1973.

Patrick, R. and C. W. Reimer. *The Diatoms of the United States, Exclusive of Alaska and Hawaii,* Volume 2, Part 1. Academy of Natural Sciences Monograph Number 13. Philadelphia, Pennsylvania. 1975.

Ponader, K. and D. Charles. *New Jersey Periphyton Bioassessment Development Project—Trophic Diatom Interface Models and Index for New Jersey Wadeable Streams—Year 5*. New Jersey Department of Environmental Protection, Division of Science, Research and Technology (DRST). Trenton, NJ. 2005.

Porter, S. D., T. F. Cuffney, M. E. Gurtz, & M. R. Meador. *Methods for Collecting Algal Samples as Part of the National Water-Quality Assessment Program (NAWQA).* Department of the Interior. U.S. Geological Survey Open File Report 93-409. Raleigh, NC. 39 pages. 1993.

Prescott, G. W. How to Know the Freshwater Algae. Third edition. WCB McGraw-Hill. Boston, Massachusetts. 1978.

Sabater, S., E. Navarro, & H. Guasch. *Effects of Copper on Algal Communities at Different Current Velocities.* Journal of Phycology 14:391-398. 2002.

Smith, G.M., The Freshwater Algae of the United States. Second edition. McGraw-Hill Book Company. New York, New York. 1950.

St-Cyr, L., A. Cattaneo, R. Chassee, and C. G. J. Fraikin. Technical Evaluation of Monitoring Methods Using Machrophytes, Phytoplankton and Periphyton to Assess the Impacts of Mine Effluents on the Aquatic Environment. Canada Center for Mineral and Energy Technology, Ottawa, Ontario. 1997.

Stevenson, R. J. and L. L. Bahls. *Chapter 6: Periphyton Protocols: Monitoring and Assessing Water Quality. In* Barbour, M.T., J. Gerritsen, B. D. Snyder, & J. B. Stribling. 1999. Rapid Bioassessment for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. Second Edition. EPA 841-B-99-002. U. S. Environmental Protection Agency. Office of Water. Washington, D.C. 1999.

Stevenson, R. J., and Y. Pan. *Assessing Ecological Conditions in Rivers and Streams with Diatoms*. Pages 11-40 *In* E. F. Stoemer and J. P. Smol, editors. The Diatoms: Applications to the Environmental and Earth Sciences. Cambridge University Press, Cambridge, United Kingdom. 1999.

Takamura, N., F. Kasai, and M. M. Watanabe. *Effects of Cu, Cd, and Zn on Photosynthesis of Freshwater Benthic Algae.* Journal of Applied Phycology 1:39-52. 1989.

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation, DOE-Oversight Division, Oak Ridge, Tennessee. 2006.

Thomasson, D. A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Vitousek, P. M., H. A. Mooney, J. Lubchenko, and J. M. Melillo. *Human Domination of Earth's Ecosystems.* Science 277:494-499. 1997.

Wehr, J. D., and R.G. Sheath, editors. *Freshwater Algae of North America: Ecology and Classification.* Academic Press (Elsevier Science). New York, New York. 2003.

Canada Geese Monitoring

Introduction

A large population of Canada geese, both resident and transient, visits the Oak Ridge Reservation (ORR). While migratory geese have always visited East Tennessee, Tennessee Valley Authority (TVA) and the Tennessee Wildlife Resources Agency (TWRA) introduced the resident population to the Melton Hill region in 1972. Geese prefer to eat grass, but will also eat water plants including root nodules from bottom sediment. Studies in the 1980s demonstrated that geese associated with the contaminated ponds/lakes on the ORR can accumulate radioactive contaminants quickly and contaminated geese frequent off-site locations. The thriving goose population in this area makes this animal an easily accessible food source for area residents. Although hunters are offered the opportunity for a radiological screening of their kills, not many take advantage of this service (TWRA, personal communication).

Results of Tennessee Department of Environment and Conservation, Department of Energy Oversight Division (the Division) off-site sampling in 1999 showed no elevated levels of radioactivity in the geese sampled. Similarly, all geese captured during the 1999, 2000, and 2001 "goose roundups" were below the 5-pCi/g game confiscation level, which DOE Oak Ridge has set as an administrative guideline. During the 2002 ORR "goose roundup," three geese were captured from ONRL that had Cs-137 levels above the 5 pCi/g game confiscation level. Geese subsequently captured in off-site sampling at the Oak Ridge Marina showed no Cs-137 or other contamination above the confiscation level. During the 2007 "goose roundup," all geese sampled were below the 5 pCi/g game confiscation level.

Geese with elevated levels of Cs-137 in muscle tissue have been found primarily in areas near ORNL. A study in September 1998 found elevated levels of Cs-137 in grass and sediment at two reaches of White Oak Creek south of the 3513 Pond and in grass around the 3524 Pond. Sediment in and around White Oak Lake (WOL) and White Oak Creek has elevated levels of Cs-137. Canada geese have been observed on WOL and throughout the ORNL area. After a flock of radioactive geese was found at ORNL in 1998, DOE took several measures to discourage the geese from using and feeding in contaminated areas. Flagging and fencing were improved and several areas were defoliated. These measures appear to have been successful, with no significantly contaminated geese being captured on or off the reservation in 1999 through 2001. State geese sampling will only take place if any of the geese captured in the 2008 "goose roundup" show significantly elevated levels of radioactivity (above 5 pCi/g). This would indicate the possibility of radioactively contaminated geese leaving the reservation.

Methods and Materials

During the week preceding the "goose roundup", areas around the perimeters of the ORR will be scouted to identify locations of possible populations of geese. This will facilitate activities on the day of collection by predetermining likely locations to sample.

Sampling would take place immediately after the annual ORR "goose roundup" with equipment and assistance from TWRA and ORNL. Geese are molting in mid-June and are nearly flightless

at this time. Sampling will take place over a one- to two-day period. Variables such as flock location and ease of capture will affect the schedule.

The site selected should be near contaminated vegetation, water, and sediment. An optimum site is the Jones Island area in Loudon County. Geese from this area have access to White Oak Lake and other contaminated ORNL sites. Due to recent movements of populations, the most likely locations will be the Oak Ridge Marina and the Solway Park areas.

Geese would be captured using the same technique as the DOE "goose roundup". Eight to fifteen people would slowly converge on a flock of geese forcing them into a temporary enclosure consisting of chicken wire and reinforcing bar. At least 15 individual geese would be captured to assure accuracy of the reading and a representative sample of the flock. Geese would be transported in cages to the TWRA check station for weighing, sexing, and a whole body count. All activities would be carried out in compliance with the Division's *Health, Safety, and Security Plan* (2005).

Results of the whole body count would determine the necessity for further analysis of the geese. If the whole body counts showed the radioactive contamination of the geese to be 5 pCi/g or greater, muscle tissue from the contaminated geese will be radiologically analyzed to confirm the results of the whole body counts and to determine if other contaminants are present. Additional analyses would be for cesium-137, mercury, cadmium, selenium, and lead in the breast and/or leg tissue of geese with whole body counts above 5 pCi/g. Up to six geese (two high, two medium, and two low whole body counts) would be analyzed from a contaminated flock.

Most material will be provided by TWRA. This includes:

- fencing
- cages
- tags

The whole-body counters are the property of ORNL and would be operated by their personnel.

References

Ashwood, T.L., Editor. *Seventh Annual Report on the ORNL Biological Monitoring and Abatement Program,* Publication Number 4074, Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, Tennessee. 1993.

Blaylock, B.G., M. L. Frank, F.O. Hoffman, L. A. Hook, G.W. Suter, J. A. Watts. *Screening of Contaminants in Waste Area Grouping 2 at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* ORNL/ER-62/R1, U.S. Department of Energy, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1992.

Crabtree, H. Notes and draft *Summary of Findings to Date, Relative to Thirty-eight Geese Found to Exceed Screening Levels for Radioactivity During the 1998 ORR Goose Roundup.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 1998.

Environmental Surveillance of the U.S. Department of Energy Oak Ridge Reservation and Surrounding Environs During 1986, Volume 2: Data Presentation, ES/ESH-1/V2. Martin Marietta Energy Systems, Oak Ridge, Tennessee, 1987

Evans, J., TWRA, personal communications.

Loar, J.M., *Fourth Annual Report on the ORNL Biological Monitoring and Abatement Program,* ORNL/TM - (Draft). U.S. Department of Energy, Oak Ridge National Laboratory. Oak Ridge, Tennessee. 1990.

Study Plan and Analysis Results from Contamination Study on Soils and Vegetation Around Ponds 3524 and 3513, First Creek and White Oak Creek. Bechtel Jacobs, Inc., 1998. Requested data.

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation. Oak Ridge, Tennessee. 2006.

Thomasson, D.A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Waters, A.E. *Radioactive and Non-Radioactive Contaminants in Migratory and Resident Waterfowl Inhabiting the Oak Ridge Reservation, East Tennessee*, Master of Science Degree Thesis, The University of Tennessee. Knoxville, Tennessee. 1990.

Monitoring of Aquatic and Terrestrial Plants in Surface Water and Ecological Habitats on the Oak Ridge Reservation

Introduction

The gathering of collateral information in support of the Division's groundwater monitoring efforts at springs and surface waters will be a priority of this project. If surface water bodies (springs and ponds) have been impacted by hazardous substances, it is likely that aquatic organisms in the immediate vicinity could be uptaking radionuclides or other hazardous substances. The focus of the plan will be the detection and characterization of hazardous substances bioaccumulated by this aquatic and terrestrial vegetation to determine ecological and human health risk factors.

Target vegetation for sampling will include (but not be limited to) watercress, green algae (*Ulothrix, Spirogyra, Oedogonium*, etc.), periphyton (benthic algae; see discussion below), mosses (*Bryophyta*), liverworts (*Hepatophyta*), horsetail and quillworts (*Equisetum* and *Isoetes*), floating & attached aquatic plants (*Azolla, Lemna, Wolffia, Salvinia*), club moss (*Huperzia sp*.), and lichens (*Cladina sp.* and *Cladonia sp*.). These plant species have been selected because they are excellent bioindicators and are remarkably sensitive to pollution, radioactive fallout, and other hazardous substances (e.g., pathogenic organisms, chemicals, metals, etc.). Also, the plants are known to be ingested by aquatic organisms and herbivores.

Watercress, a floating, rooted aquatic plant (angiosperm) has been selected for its affinity to thrive in its natural habitat, the clear, slow-moving water near the mouths of springs. If the spring water is impacted, aquatic plant species are likely to have absorbed some of the hazardous substances.

Green algae and periphyton occur in most of the aqueous environments within ORR watersheds (e.g., Upper East Fork Poplar Creek). Periphyton refers to communities of microorganisms that are attached to various aquatic substrates and grow as thick gelatinous mats of mixed assemblages. These include green algae, cyanobacteria, fungi, associated macrophytes (e.g., cattails, duckweed, water spangles, etc.), invertebrate grazers (e.g., snails), and detritus. For many aquatic organisms and herbivores, periphyton biomass produces much of the low end of the food chain. They are sensitive indicators of environmental physiochemical change and bioaccumulation of hazardous substances.

Prospective habitats, both on and off of the ORR, such as springs, seeps, karst features, streams, wetlands, impoundments (ponds), landfills, creek embankments, rock outcrops, State Natural Areas, and other terrestrial ecosystems will receive priority as potential monitoring sites (see Figures 1 and 2). Watersheds such as Bear Creek and its tributaries, White Oak Creek/Lake and its tributaries, and Mitchell Branch are all probable target habitats for sampling.

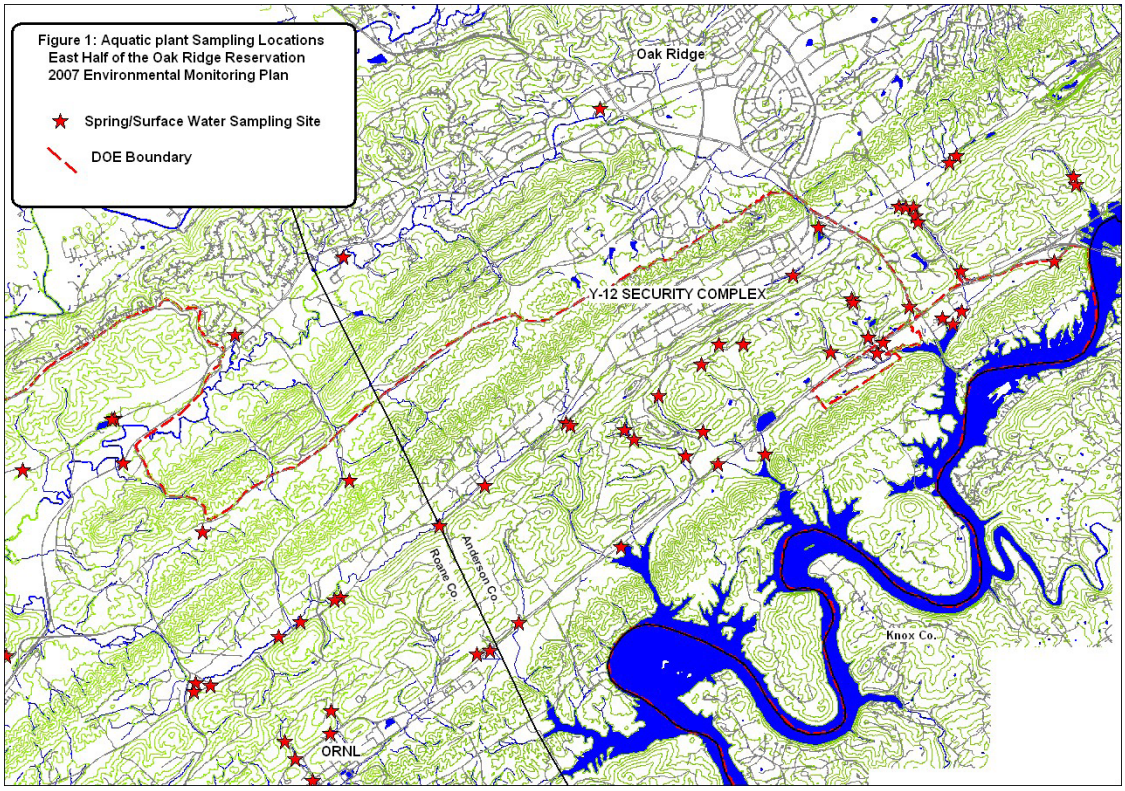

Figure 1: Potential Aquatic Plant Sampling Locations - East Half of ORR

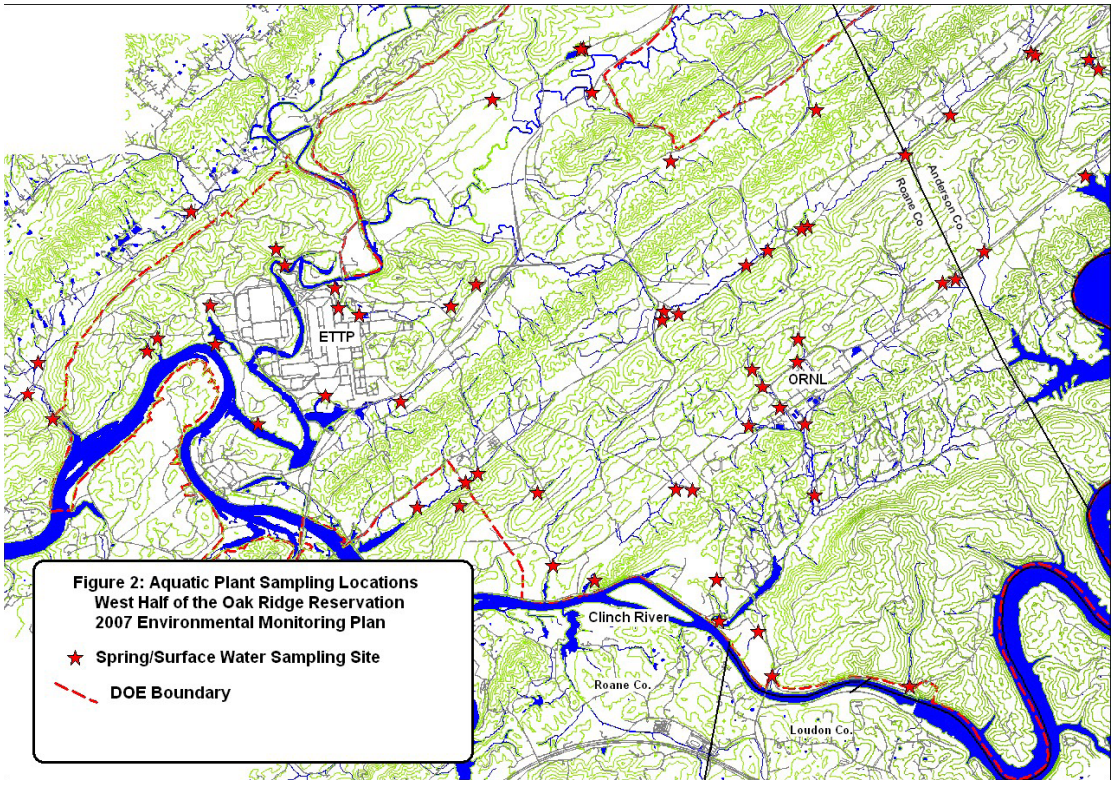

Figure 2: Potential Aquatic Plant Sampling Locations – West Half of ORR

The first two sampling seasons (2002-03) concentrated on the sampling and analysis of watercress, algae, and aquatic vegetation. In 2004, the project broadened in scope to include determinations of the ecological implications of these findings. In 2005, the focus was turned to the highest results from previous sampling to determine if a threat existed. In 2006, a spring and seep survey was conducted near areas of concern in order to more closely evaluate potential hot spots. In 2007, the monitoring of existing sites was performed and several additional areas of concern were sampled. In 2008, the five sites with the highest results will be re-sampled in order to determine if natural attenuation is occurring, and a spring and seep survey will be conducted to find five new sites of interest to be sampled.

Methods and Materials

Field samples will be collected at habitats and ecosystems both on the ORR and offsite (for background data). Plastic zip-lock baggies and plastic (jar-like) containers will be used for collection of samples in the field. Rubber/plastic gloves will be worn during sampling activities. Each sampling location will be assigned an identification number (established spring names will be used for watercress samples) and mapped using global positioning system (GPS) technology.

Arrangements will be made in advance with appropriate Tennessee Oversight Agreement site coordinators to orchestrate ingress/egress to radiological areas, to obtain Radiation Worker Permits (if necessary), and to arrange for the presence of health physics technicians on an as-needed basis. All samples will be screened radiologically in the field prior to returning to the Division's office. Using radiological counting equipment available in the Division laboratory, exposure rates will be calculated from selected field samples to determine exposure, absorbed dose, etc.

Samples collected will be shipped to Laboratory Services in Nashville for analysis of gross alpha, gross beta, and gamma radionuclides. Target radionuclides occurring in the ORR environment as contamination include (but are not limited to):

- cesium-137
- strontium-90
- cobalt-60
- uranium isotopes and daughter products
- technetium-99

Sampling protocol and quality control methods will follow the guidelines in the Division's *Standard Operating Procedures* and *Health, Safety, and Security Plan*. Field techniques and laboratory methods will follow standard ASTM, EPA, and FRMAC methodology, sampling, and operating procedures. Standard Operating Procedures for the project include (but are not limited to):

(1) ASTM Guidelines:
ASTM Volume 11.02 – Organic Constituents/Radioactivity/Microbiological
ASTM Volume 11.05 – Biological Effects & Environmental Fate/Biotechnology
ASTM Volume 12.02 – Nuclear/Solar/Geothermal/Dosimetry/Radiation Effects

(2) Federal Radiological Monitoring and Assessment Center (FRMAC) – 2005:
Vol. 1 – Radiation Monitoring & Sampling - Field Sampling: Vegetation/Fruit Sampling, Supplies and Procedure.
Vol. 2 - Sample Preparation and Analysis – Method 6: Preparation of FRMAC Field Samples
Vol. 2 - Sample Preparation and Analysis – Method 7: Gamma Emitting Radionuclides in FRMAC Samples

(3) Methods for Collection and Analysis of Aquatic Biological & Microbiological Samples: Book 5, Chapter A4, U.S. Geological Survey.

(4) Wetlands Delineation Manual, U. S. Army Corps of Engineers

(5) Standard Operating Procedure – Ash Free Dry Basis – Periphyton, U. S. Environmental Protection Agency

References

Algae, U. S. Geological Survey, May 2000. http://il.water.usgs.gov/proj/lirb/eco/collect_method/algae.html

Algal and Microbial Communities as Indicators of Prairie Wetland Integrity, Excerpts from Bioindicators for Assessing Ecological Integrity of Prairie Wetlands Report, EPA/600/R-96/082, U. S. Environmental Protection Agency. September 1995. http://www.epa.gov/owow/wetlands/wqual/pph2_2.html

BMAP Site Specific Results – Paducah Gaseous Diffusion Plant, Kentucky: Bioaccumulation Monitoring. U. S. Department of Energy, Oak Ridge National Laboratory, Environmental Sciences Division, April 2001. http://www.esd.ornl.gov/BMAP/ky_bioaccum.htm

Barnthouse, Lawrence W., *Effects of Ionizing Radiation on Terrestrial Plants and Animals: A Workshop Report*, Pub. No. 4494, ORNL/TM-13141, Oak Ridge National Laboratory, Environmental Sciences Division. Oak Ridge, Tennessee. 1995.

Bioindicators of Aquatic Ecosystem Stress, U. S. Department of Energy, Oak Ridge National Laboratory Services, Environmental Sciences Division, August 1997. http://www.esd.ornl.gov/programs/bioindicators/index.html

Biological Indicators of Watershed Health – Periphyton as Indicators, U. S. Environmental Protection Agency, August 2002. http://www.epa.gov/bioindicators/html/periphyton.html

Biological Monitoring and Abatement Program (BMAP). U. S. Department of Energy, Oak Ridge National Laboratory, Environmental Sciences Division, April 2001. http://www.esd.ornl.gov/BMAP

Britton, L. J., and P.E. Greeson. *Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples,* Book 5, Chapter A4, Techniques of Water Resources Investigations of the U. S. Geological Survey. U.S. Department of the Interior, U. S. Government Print Office, Washington, DC, 1989. http://www.deq.state.mt.us/ppa/mdm/SOP/pdf/12-1-2-0.pdf

Contaminants in Aquatic Habitats at Hazardous Waste Sites: Mercury. NOAA Technical Memo NOS ORCA 100. National Oceanic and Atmospheric Administration (NOAA). December 1996. http://response.restoration.noaa.gov/cpr/sediment/mercury.pdf

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Environmental Protection Agency, Region IV, Atlanta, Georgia. May 1996.

Field Sampling Plan – Algal Survey, Rouge River National Wet Weather Demonstration Project May 1997. http://www.rougeriver.com/pdfs/sampling/fsp14.pdf

Gaiser, Evelyn, et al. *Periphyton*. Florida International University. Miami, Florida. 2002. http://www.fiu.edu/~serp/jrpp/flume2.pdf

Memorandum of Agreement Between the Department of Conservation and Environment & the Department of Health for Analysis of Environmental Samples, State of Tennessee, 2006.

Parrington, Josef R., et al. *Nuclides and Isotopes - Chart of the Nuclides*, 15th Edition, General Electric Company and KAPL, Inc., 1996.

Radiation Monitoring & Sampling - Field Sampling: Vegetation/Fruit Sampling, Supplies and Procedure, Vol. 2 - Sample Preparation and Analysis – Method 6: Preparation of FRMAC Field Samples, Vol. 2 - Sample Preparation and Analysis – Method 7: Gamma Emitting Radionuclides in FRMAC Samples, Vol. 1 Federal Radiological Monitoring and Assessment Center (FRMAC), 2005.

Raven, Peter H., et al, *Biology of Plants*, 6th Edition, W. H. Freeman & Company. 1999.

Standard Operating Procedure #1131: Ash Free Dry Mass – Periphyton. U. S. Environmental Protection Agency, Region 9 Laboratory, August 1997 http://www.epa.gov/region09/lab/sop/1131.pdf

Taylor, F. G., *Inventory of ORNL Remedial Action Sites: 6 Environmental Research Areas*, Letter Report RAP86-18/R1, U.S. Department of Energy, Oak Ridge National Laboratory, Environmental Sciences Division. Oak Ridge, Tennessee. June 1986.

Tennessee Oversight Agreement, *Agreement Between the U.S. Department of Energy and the State of Tennessee*, Tennessee Department of Environment and Conservation. Oak Ridge, Tennessee. 2006.

Thomasson, D.A., *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Wetlands Delineation Manual, U. S. Army Corps of Engineers, November 1995. http://www.wetlands.com/coe/87manp1a.htm

Wetlands – Wetland Algae: Impacts of Quality of Inland Wetlands of the United States: A Survey of Indicators, Techniques, and Applications of Community Level Biomonitoring Data, Excerpts from Report EPA/600/3-90/073, U. S. Environmental Protection Agency, July 2002. http://www.epa.gov/OWOW/wetlands/wqual/algae.html

Willow Creek Final Project Report: Periphyton, Environmental Assessment Office (EAO)/Willow Creek Coal Company. September 1997.

This page intentionally left blank.

DRINKING WATER MONITORING

Sampling of Oak Ridge Reservation Potable Water Distribution Systems

Introduction

The water distribution systems at each of the DOE ORR sites are regulated by the *Tennessee Safe Drinking Water Act,* (T. C. A. 68-13-701), and by the *Regulations for Public Water Systems and Drinking Water Quality* (Chapter 1200-5-1). The Tennessee Department of Environment and Conservation, Department of Energy Oversight Division (the Division) may conduct oversight of sampling for total coliform bacteria and free chlorine residuals at various sites throughout the potable water distribution systems on the Oak Ridge Reservation (ORR). In addition, the Division will oversee ORR line-flushing practices, water main repairs, cross-connection control programs, and water-loss/leak detection activities in order to identify potential threats to the potable water supply. If potential threats are identified, then additional chemical and radiological sampling may be conducted during 2008 to insure that the quality of the potable water is maintained.

The Division, through a memorandum of understanding (MOU) with the TDEC Division of Water Supply (DWS), reviews chemical and bacteriological sampling results from the drinking water distribution systems on the ORR. Review of these sampling results will be combined with

- knowledge of localized plant populations and water demand,
- backflow device location,
- testing and maintenance procedures, and
- line repairs or maintenance.

When evidence exists of possible shallow subsurface plume infiltration, cross connections, low chlorine residuals, or other upset conditions, the Division will use site maps to identify the proximity of water lines to radiological or non-radiological source waters. This will be used as a basis for independent sampling. Free chlorine tests on potable water will be conducted once a quarter per site. Bacteria samples will also be collected once a quarter per site and the sites will be located as close as possible to dead-end lines and shallow subsurface plumes.

Confirmation of any positive results reported can dictate additional sampling or split samples. Continued positive results may justify increased monitoring for that compound.

In addition, review of Cross Connection Control Programs will be conducted to evaluate the effectiveness of such plans and the degree of protection afforded by them. This will be checked by verifying inspection dates on backflow prevention (BFP) devices, review of records of BFP devices, oversight of actual preventer testing, and inspection for possible unprotected cross connections. This will entail visiting each site (Y-12, ETTP and ORNL) at least once to visually inspect the records to insure compliance with the regulatory requirement for current Cross Connection Controla Plans. Once the records are viewed, a large proportion of the BFPs will be visually inspected to oversee compliance.

Additional information concerning potential threats to water distribution systems is provided in a set of articles (http://www.epa.gov/safewater/tcr/tcr.html#distribution) prepared for the EPA. The papers only present available information and do not represent EPA policy.

Methods and Materials

The following sections provide information regarding the sample processing and analytical laboratory procedures.

Free Chlorine Residual
The sample will be collected into two of the small sample containers provided with the Hach® Pocket Colorimeter Kit. One of the samples will be designated as the blank and the other will be the actual sample to be analyzed. A DPD powder pillow (test reagent) is poured into the sample container and gently shaken and allowed to sit for three minutes. After three minutes, the blank is placed into the pocket colorimeter and the "zero" button is depressed. The blank is removed and replaced with the sample container. The "read" button is depressed and the free chlorine residual is read directly from the pocket colorimeter display.

Bacteriological
The U.S. Environmental Protection Agency (EPA)-approved method for coliforms (Colilert® in the pass/fail mode) will be the methodology utilized by Laboratory Services. The lab has expertise in a broad scope of services and analyses available to the Division and other TDEC divisions statewide. For bacteriological testing on raw water sources, the counting application of the Colilert kits would be identified and utilized.

Independent chlorine and bacteriological sampling will be conducted monthly at one of the three DOE facilities. Reasonable attempts will be made to rotate sampling between facilities each month. Specific sampling sites and number of samples to be taken will be determined based on water usage patterns, distribution system layouts, and other factors, such as construction activities and line breaks.

Organic, Inorganic and Radiological
Analytical methods are provided in the Standard Operating Procedures (SOP) manuals for Laboratory Services. The SOPs refer to proper EPA and/or other methods. In order to assess methods used, Division staff will communicate with their sampling and analytical counterparts within the ORR on a basis that facilitates technical exchange and openness. General sampling and analysis methods will follow EPA guidelines as listed in the appropriate section of *Title 40 of the Code of Federal Regulations* (CFR).

Sampling of organic, inorganic, and radiological constituents will be conducted on an as needed basis when it has been determined that a possible threat to the quality of the drinking water exists.

Quality Control/Quality Assurance
If independent sampling activities are conducted, care will be taken to include quality control

samples. The level of quality control methodology implemented will be commensurate with the level of independent sampling. Forms of control sampling to be considered will be blanks, duplicate analysis, division-split samples, or even-split samples with site DOE contractors. Information pertaining to the quality control samples will be included in program files and spreadsheets.

Equipment that will be required to accomplish this oversight and sampling project include:

- latex or vinyl exam gloves
- Hach Pocket Colorimeter Kit
- Hach free chlorine DPD powder pillows
- bound field book
- State vehicle
- *Health, Safety, and Security Plan*
- sample bottles
- sampling cooler
- disinfectant (full strength) spray bottle

References

Cross Connection Control Manual. EPA 570/9-89-007. U.S. Environmental Protection Agency June 1989.

Cross Connection Control Manual. Tennessee Department of Environment and Conservation, Division of Water Supply. Nashville, Tennessee. 1988.

Regulations for Public Water Systems and Drinking Water Quality (Chapter 1200-5-1), Tennessee Department of Environment and Conservation, Division of Water Supply. Nashville, Tennessee.

Tennessee Oversight Agreement, Agreement Between The U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation. Oak Ridge, Tennessee. 2006.

Tennessee Safe Drinking Water Act, (T.C.A. 68-13-701), Tennessee Department of Environment and Conservation, Nashville, Tennessee.

Thomasson, D. A. *Health, Safety, and Security Plan,* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, Oak Ridge, Tennessee, 2005.

Total Coliform Rule, U.S. Environmental Protection Agency, Office of Drinking Water and Ground Water. http://www.epa.gov/safewater/tcr/tcr.html#distribution

RadNet Drinking Water Program on the Oak Ridge Reservation

Introduction

Radiological contaminants released on the Oak Ridge Reservation (ORR) enter local streams and are transported to the Clinch River. Though monitoring of the river and local water treatment facilities has indicated that concentrations of radioactive contaminants are below regulatory criteria, the possibility that ORR pollutants could impact area water supplies remains. In response to this potential, the Tennessee Department of Environment and Conservation, DOE Oversight Division (the Division) began participation in EPA's Environmental Radiation Ambient Monitoring System (ERAMS) in 1996. This program, now called RadNet, provides for radiological monitoring of public water supplies near major population centers throughout the United States. In this regard, the RadNet program is designed

- to monitor pathways for significant population exposure from routine and/or accidental releases of radioactivity
- to provide data indicating additional sampling needs or other actions required to ensure public health and environmental quality and,
- to serve as a reference for data comparison (U.S. EPA, 1988)

The program also provides a mechanism to evaluate the impact of DOE activities on water systems located in the vicinity of the Oak Ridge Reservation and to verify DOE monitoring in accord with the *Tennessee Oversight Agreement* (TDEC, 2006).

Methods and Materials

As in the past, EPA will provide radiochemical analysis of finished drinking water samples collected quarterly by Division staff at five public water supplies located on, and in the vicinity of, the ORR. This analysis will be performed at EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama. When received, the results will be compared to each other (to identify anomalies) and to DOE/EPA drinking water standards (to assess DOE compliance, the adequacy of contaminant controls, and any associated hazards). Analytical parameters and the frequencies of RadNet analysis are provided in Table 1.

The five Oak Ridge area monitoring locations in the program are the Kingston Water Treatment Plant, the Gallaher (K-25) Water Treatment Plant, West Knox Utility, the City of Oak Ridge Water Treatment Facility (formerly the DOE Water Treatment Plant at Y-12), and Anderson County Utility District. Figure 1 depicts the approximate locations of raw water intakes associated with these facilities.

Table 1: RadNet Analysis for Drinking Water

ANALYSIS	FREQUENCY
tritium	Quarterly
gross alpha	Annually on composite samples
gross beta	Annually on composite samples
gamma scan	Annually on composite samples
iodine-131	Annually on one individual sample/sampling site
radium-226	Annually on samples with gross alpha >2 pCi/L
radium-228	Annually on samples with Radium-226 between 3-5 pCi/L
strontium-90	Annually on composite samples
plutonium-238, plutonium-239, plutonium-240	Annually on samples with gross alpha >2 pCi/L
uranium-234, uranium-235, uranium-238	Annually on samples with gross alpha >2 pCi/L

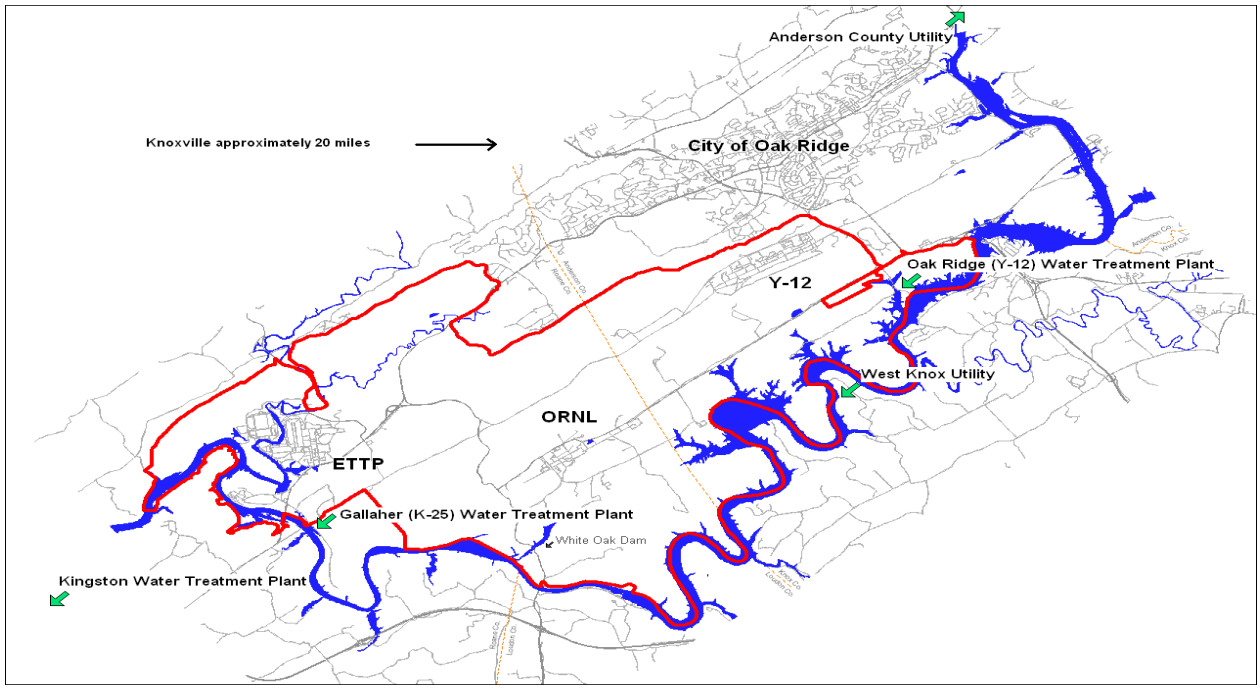

Figure 1: Approximate locations of the intakes for public water systems monitored in association with EPA's RadNet drinking water program

References

Environmental Radiation Ambient Monitoring System (ERAMS) Manual, EPA 520/5-84-007, 008, 009, U.S. Environmental Protection Agency, May 1988.

Environmental Radiation Data Report 123, EPA-402-R-97-004, U.S. Environmental Protection Agency, data from July - September 2005. http://www.epa.gov/narel/radnet/erd/erd123.pdf

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation. Oak Ridge, Tennessee. 2006.

Thomasson, D.A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

U.S. Environmental Protection Agency. http://oaspub.epa.gov/enviro/erams_query.simple_query (Last updated November 1, 2007)

U.S. Environmental Protection Agency. http://www.epa.gov/narel/radnet/programs.html#air (Last updated August 13, 2007).

This page intentionally left blank.

GROUNDWATER MONITORING

Groundwater Monitoring Plan for the Oak Ridge Reservation and Its Environs

Introduction

In concordance with the mission of the State's Department of Energy Oversight Division (TDEC/DOE-O) as established under the Tennessee Oversight Agreement (TOA) and the (Federal Facilities Agreement (FFA), to protect the people and environment of East Tennessee, in respect to wastes and contaminants generated by Oak Ridge Reservation (ORR) Department of Energy (DOE) operations both legacy and current, the Division conducts monitoring of the groundwaters of the Oak Ridge Reservation and its environs.

The primary goals of the DOE-Oversight Division's groundwater sampling program during 2008 are to plan and conduct an offsite groundwater monitoring program for the purpose of protecting the people and environment of the regions of East Tennessee, where the potential exists of impact to groundwaters by past and or present activities of the DOE on or off the ORR and in support of the above where feasible, to locate and monitor groundwater exit pathways within the peripheral areas of the ORR.

Description

Offsite residential well monitoring will be the primary focus of the Division's groundwater monitoring program in 2008. Since DOE's cessation of offsite groundwater monitoring in year 2000, the Division has been the only agency conducting offsite monitoring of groundwater resources. Findings from offsite monitoring in summer and fall of 2007 further demonstrated that offsite groundwater quality concerns would, of necessity, become a priority for the division groundwater program.

Onsite (ORR) monitoring by the division's groundwater program will be limited to activities that directly support the offsite ground water monitoring effort. In general these will consist of seeps, springs and wells located on the periphery of DOE properties that are known or suspected of having been impacted by DOE's legacy or current activities. Analytes for samples will be chosen based on known DOE contamination in the area and the need for geochemical comparisons of groundwaters.

The Division will, within the scope of its mission, attempt to provide as much coverage of offsite groundwater as is feasible. It is expected in 2008 to add offsite locations as they become available either through requests received by the Division from the public or by staff initiative in contacting private well owners who have locations considered to meet the monitoring criteria cited above.

Reconnaissance
The groundwater program will conduct efforts to locate springs, seeps, and wells either offsite or on the periphery of the ORR that are may have been impacted DOE activities. If feasible, detailed geologic maps may be generated with the cooperation of the Division of Geology

Methods and Materials

Sampling will generally be undertaken along geologic strikes and along cross-strike geologic features around the historically named Y-12, X-10, K-25 and the South Campus facilities. Water supply wells will be sampled by collecting water as close to the wellhead as possible. Water supply wells will be purged for at least 20 minutes until field parameters stabilize. Monitoring wells will be co-sampled along with facility personnel or by Division personnel using disposable bailers. Parameters, such as, pH, temperature, and conductivity will be collected before sampling and recorded on a sampling chain of custody sheets. Springs will be sampled based on field observation of flow and safety considerations.

Table 1 contains locations, analyses and sampling periods as described below. Specific radiochemical analyses will be determined prior to sampling. These may be modified upon consultation with the Radiological Monitoring Oversight Program (RMO). Typically, waters *a priori* influenced by K-25 would be analyzed for Tc-99. If domestic water supplies show a gross alpha activity greater than 5 picocuries/liter then a radionuclide isotope specific analysis for alpha emitters will be performed on the laboratory-archived sample.

New sampling locations will include cation/anion parameters in order to calculate ionic charge balances. A list of metals that may include the health-based analytes will be considered for analysis at new locations. Samples will be tested for volatile organic compounds (VOCs) at all new springs. At sampling points where metals, VOCs, or radionuclide results indicate a need to determine variability, then appropriate follow-up samples will be collected and analyzed.
As new contaminants of concern are identified by the regulatory and monitoring community new parameters may be added to the analysis of ground and surface waters sampled by the program. The Tennessee Department of Health analytical laboratory in Knoxville, Tennessee will furnish sample containers. Samples will be collected using approved TDEC and EPA sampling procedures. The use of vinyl exam gloves and decontamination equipment and procedures will be necessary to avoid cross contamination. TDEC DOE-O sample coolers will be used to insure that samples are preserved in route to the laboratory.

Appropriate lab, field and trip blanks will be utilized.

DOE Coordination/Communication
DOE will be notified of Division groundwater sampling plans by this document, monitoring meetings, and revisions to this document. Should the DOE request the opportunity to observe and/or take split samples, every effort will be made to facilitate DOE participation in the Division‘s Groundwater Program. Analytical results will be made available to any and all interested parties upon request.

All results and findings will be reported in the DOE-Oversight Division’s Environmental Monitoring Report. It is anticipated there will be two sections in the 2009 Environmental

Monitoring Report covering offsite sampling results (private residential and non-community wells, and springs) and exit pathway investigations.

Table 1: Sampling and Analysis Matrix for 2008 Groundwater Program

Area	Quarters				Locations with sampling frequency other than quarters are noted by spring/seep name and frequency.
	Q1	**Q2**	**Q3**	**Q4**	
K-25	VOCs Rad Dye	VOCs Rad Dye	VOCs Rad Dye	VOCs Rad Dye	1. Spring 10-895 (M) 2. PCO Seep (Q1, Q4) 3. Rubble Seep (Q1, Q4) 4. Tree Hole Spring (Q) 5. Lila's Leak (Q)
	VOCs Rad Met Inor	VOCs Rad Met Inor	VOCs Rad Met Inor	VOCs Rad Met Inor	6. USGS 8-900 (Q)
Bethel Valley	Rad VOCs		Rad VOCs		1. Sycamore Spring (Q1,Q4)
Melton Valley	Rad VOCs		Rad VOCs		1. Picket Wells TBD (est. 20 samp) 2. Wetland Spring (Y)
Off-Site	Rad VOCs	Rad VOCs	Rad VOCs	Rad VOCs	1. Cattail Spring (Q) 2. Bootlegger Spring (Q) 3. Arboretum Wells (Y)
Off-Site	Rad VOCs Met	Rad VOCs Met	Rad VOCs Met	Rad VOCs Met	1. Rose Bailey Lake Spring Wells (Y) 2. Love Spring (Y) 3. Dead Horse Spring (Y) 4. Regina Loves Bobby Spring (Q) 5. RWA-22 (Y) 6. RWA-29 (Y) 7. RWA-56 (M) VOCs (Q) 8. RWA-63 (M) VOCs (Q) 9. RWA-65 (M) VOCs (Q) 10. RWA-74 11. RWA-75 12. RWA-76 (M) VOCs (Q) 13. RWA-78 (M) VOCs (Q) 14. UA-1 (Q) 15. UA-2 (Q) 16. (up to 20 additional) (Q)

NOTES
Q = sample collected quarterly
Y = sample collected annually
M = sample collected monthly
Rad = sample for radiochemicals: gross alpha, gross beta, gamma radionuclides, occasionally strontium89/90, tritium, transuranics, and/or technetium 99
VOCs = samples for volatile organic compounds
Nut = samples for nutrients (nitrate – nitrite)
Met = a sample that is analyzed for arsenic, beryllium, cadmium, chromium, cobalt, nickel, lead, selenium, thallium, vanadium, and. occasional mercury
Inor = general inorganic parameters: alkalinity as CaCO3, boron, chloride, conductivity, nitrogen NO3 & NO2, pH, residue dissolves, residue, suspended, sulfate
Dye = samples for dye resulting from dye traces by contractors, utilities, or TDEC DOE-O

References

Bailey, Z. C. and Roger W. Lee. *Hydrology and Geochemistry in Bear Creek Valley Near Oak Ridge, Tennessee.* Water-Resources Investigations Report 90-4008. U. S. Geological Survey. 1991.

Davies, Gareth J. *Water Temperature Variation at Springs in the Knox Group Near Oak Ridge, Tennessee*. In Proceedings of the 3rd Conference on Hydrogeology, Ecology, Monitoring, and Management of Groundwater in Karst Terrains. Nashville, Tennessee: p. 197. 1991.

Hatcher, R. D., P. J. Lemiszki, R. B. Dreier, R. H. Ketelle, R. R. Lee, D. A. Lietzke, W. M. McMaster, J. L. Foreman, and S. Y. Lee. *Status Report on the Geology of the Oak Ridge Reservation.* ORNL/TM-12074. Oak Ridge National Laboratory. Oak Ridge, Tennessee. 1992.

King, H. L. and C. Stephen Haase. *Subsurface-Controlled Geological Maps for the Y-12 Plant and Adjacent Areas of Bear Creek Valley.* ORNL/TM-10112.Martin Marietta Energy Systems. Oak Ridge, Tennessee. 1987.

Martin Marietta Energy Systems. *A Study of Groundwater Flow from Chestnut Ridge Security Pits Using a Fluorescent Dye Tracer.* Y/SUB/90-00206C/6. Prepared by Geraghty & Miller, Inc. Oak Ridge, Tennessee. 1990.

Martin Marietta Energy Systems. *Final Report of the Second Dye Tracer Test at the Chestnut Ridge Security Pits, Oak Ridge, Tennessee.* Y/SUB/93-99928c/Y10/1. Prepared by Science Applications International Corporation. Oak Ridge, Tennessee. 1992.

Rubin, Paul A. and Peter Lemiszki. *Aspects of Oak Ridge Karst Hydrology and Geomorphology. Characterization Plan With Emphasis on the K-25 Bedrock Flow System.* Unpublished report for Martin Marietta Energy Systems/Department of Energy. Oak Ridge, Tennessee. 1992.

Smart, P. L. and I. M. S., Laidlaw. 1977. *An Evaluation of Some Fluorescent Dyes for Water Tracing.* Water Resources Research. Vol. 13. No. 1: 15-33.

Tennessee Department of Environment and Conservation Department of Energy Oversight Division. Spring Monitoring Data-1994-2001. Unpublished data.

Tennessee Department of Environment and Conservation Department of Energy Oversight Division. *Work Plan for Dye Trace Study at the Chestnut Ridge East Borrow Area Y-12 Plant Oak Ridge, Tennessee.* Oak Ridge, Tennessee. 1995.

Tennessee Department of Environment and Conservation Department of Energy Oversight Division. *Standard Operating Procedures.* Oak Ridge, Tennessee. 1996.

Tennessee Department of Environment and Conservation. *Environmental Laboratory Service Guide and Sampling Manual.* Nashville, Tennessee. 1992.

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*. Oak Ridge, Tennessee. 2006.

Thomasson, D. A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

U.S. Environmental Protection Agency. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM).* Enforcement and Investigations Branch. Region IV. Athens, Georgia. 1997.

This page intentionally left blank.

RADIOLOGICAL MONITORING

Facility Survey Program and Infrastructure Reduction Activity

Introduction

The Tennessee Department of Environment and Conservation's Department of Energy Oversight Division (DOE-O), in cooperation with the U.S. Department of Energy and its contractors, operates a facility survey program (FSP) on the Oak Ridge Reservation (ORR). The DOE-O survey program provides a comprehensive, independent characterization of facilities on the ORR based on their operational history, present mission and physical condition, inventories of radiological and/or hazardous materials, degree of contamination, contaminant release history, and potential for release of contaminants to the environment.

The goal of the program is to fulfill part of the commitments agreed to by the State of Tennessee and the Department of Energy in Section 1.2.3 of the *Tennessee Oversight Agreement,* which states that "Tennessee will pursue the initiatives in attachments A, C, E, F, and G. The general intent of these action items is to continue Tennessee's: (1) environmental monitoring, oversight and environmental restoration programs; (2) emergency preparedness programs; and (3) delivery of a better understanding to the local governments and the public of past and present operations on the ORR and potential impacts on the human health and/or environment by the Oak Ridge Reservation." As part of this larger endeavor, *the facility survey program is designed to provide a detailed assessment of all potential hazards affecting or in any way associated with facilities on the Oak Ridge Reservation.* To meet this objective, survey team members walk through each facility and gather information that is recorded in a database that allows the team to characterize facilities and evaluate their potential for release of contaminants to the environment (PER). This survey of conditions considers a variety of environmental conditions ranging from catastrophic (i.e. tornado, earthquake) to normal everyday working situations. From an emergency preparedness perspective, such information is essential.

In 2002, the Department of Energy instituted a formal, accelerated D&D program aimed at facility reduction through demolition. Facility survey staff responded to this activity by making facility visits and walk-throughs of each facility prior to, and during demolition. Information concerning the nature and destination of waste streams from the demolition sites is gathered and submitted to the Division's Waste Management section. This activity will continue in 2008.

Methods and Materials

The criteria used in the selection of facilities to be surveyed include 1) position of the facility in S&M/D&D Programs, 2) perceived physical condition of facility, 3) perceived levels of contamination, 4) types or quantities of inventories (hazardous or radiological) and, 5) special circumstances (incidents, public or other agency request, or other unforeseen situations).

Using standard radiation survey instruments, inventory data, and historical documentation, staff walk through each facility and record information in a questionnaire format. Based on the results of these questionnaires and professional judgment, staff then rank the potential for release of contaminants to the environment (PER) for each facility by scoring 0 (least potential) to 5 (greatest potential) for each of 10 "categories." Tables 1 and 2 illustrate the scoring guidelines for potential environmental release, and the categories to be scored.

Table 1: Potential for Environmental Release Scoring Guidelines

Score	Score is based on observations in the field and the historic and present-day threat of contaminant release to the environment/building and/or ecological receptors.
0	No potential: no quantities of radiological or hazardous substances present.
1	Low potential: minimal quantities present, possibility of an insignificant release, very small probability of significant release, modern maintained containment.
2	Medium potential: radiological or hazardous substances present, structures stable in the near to long term, structures have integrity but are not state-of-the-art, adequate maintenance.
3	Medium potential: structures unstable, in disrepair, containment failure clearly dependent on time, integrity bad, maintenance lacking, containment exists for the short term only.
4	High potential: radiological or hazardous substances present. Containment for any period of time is questionable; migration to environment has not started.
5	Radiological or hazardous substance containment definitely breached, environmental/interior pollution from structures detected, radiological and/or hazardous substances in inappropriate places like sumps/drains/floors, release in progress, or radiological exposure rates above Nuclear Regulatory Commission (NRC) guidance.
Note: A score of 0 or 1 designates a low Potential Environmental Release rank; a score of 2 or 3 designates a moderate rank; a score of 4 or 5 designates a high rank.	

Table 2: Ten Categories Scored

1.	sanitary lines, drains, septic systems
2.	process tanks, lines, and pumps
3.	liquid low-level waste tanks, lines, sumps, and pumps
4.	floor drains and sumps
5.	transferable radiological contamination
6.	transferable hazardous materials contamination or waste
7.	ventilation ducts and exit pathways to create outdoor air pollution
8.	ventilation ducts and indoor air/building contamination threat
9.	escalated radiation exposure rates inside the facility
10.	escalated radiation exposure rates outside the facility

As facilities are surveyed, scored, and compared with each other, a relative "potential for environmental release" will emerge. The facilities that show a high potential for release of contaminants will be noted in the program's annual report. Staff will revisit these facilities at their discretion to evaluate changing conditions. Table 3 provides a list of target facilities to be surveyed during the next year.

Table 3: Target Schedule of Facilities to be Surveyed *

ORNL		Y-12		K-25	
Facility	**Date**	**Facility**	**Date**	**Facility**	**Date**
X-3042	Jan. 15	Y-9204-2E	Jan. 30		
X-4507	Mar. 15	Y-9720-53	Feb. 28		
X-2001	May 15	y-9404-16	April 30		
X-2024	July 15	y-9720-16	July 30		
X-2011	Sept. 15	y-9201-2	Oct. 31		
X-3508	Oct. 15				
On demand		On demand		On demand	

*Facility numbers and dates are subject to change.

References

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the Department of Energy and the State of Tennessee*. Oak Ridge, Tennessee. 2006

Thomasson, D.A. *Health, Safety, and Security Plan,* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 2005. Oak Ridge, Tennessee.

Yard, C.R. *Emergency Response Procedures Manual*. Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. 2005. Oak Ridge, Tennessee.

Haul Road Radiological Surveys

Introduction

The Tennessee Department of Environment and Conservation, Department of Energy Oversight Division (the Division), with the cooperation of the U.S. Department of Energy (DOE) and its contractors, will periodically perform walkover radiation surveys for the purpose of evaluating DOE property for re-use. The surveys will be conducted according to Section 120(h) of the CERCLA law process for establishing clean areas following direct guidelines. In addition, walkover surveys may be performed, as needed, in conjunction with other special projects or on-going activities.

Background of the Project

The project has incorporated the haul roads used by DOE for the transport of radiological waste on the Reservation. Reeves Road and the new haul road (unnamed and connecting ETTP to EMWMF) are currently being monitored. Under administrative controls, any areas exceeding 200 dpm/100cm^2 removable beta, 1000 dpm/100cm^2 total beta, 20 dpm/100cm^2 removable alpha, and 100 dpm/100cm^2 total alpha would require remediation. These values are conservative when compared to DOE Order 5400.5. It is important to note that portions of the new haul road contain shale, which is naturally higher in radioactive material. In addition to these two haul roads, other roads are surveyed on an interim basis as needed. Periodically, non-haul roads become haul roads for a short duration of time, typically due to construction or some other activity that cannot be avoided. During the time these roads act as haul roads they will be surveyed by the State. A thorough beta-gamma scan will be performed as well.

Methods and Materials

The walkover surveys are conducted using a physical approach. Background material in the vicinity is evaluated prior to the survey by conducting a drive-through of the area. From there, a walkover survey of the area is conducted with the use of the Division's radiological detection instruments. The instruments available for use are provided in Table 1.

Table 1: Division of DOE Oversight Portable Radiation Detection Equipment

Radiological Detection Instruments	Radiological Detection Probes	Radioactivity Measured
Ludlum Model 2221 Scaler Ratemeter	Ludlum Model 44-10 2x2in NaI Gamma Scintillator	Gamma (cpm)
Ludlum Model 3 Survey Meter	Ludlum Model 44-9 Pancake G-M Detector	Alpha, Beta, Gamma (cpm)
Ludlum Model 3 Survey Meter	Ludlum Model 43-65 50 cm^2 Alpha Scintillator	Alpha (cpm)
Bicron Micro Rem	Internal 1x1in NaI Gamma Scintillator	Tissue Dose Equivalent, Gamma (µrem/hr)
Bubble Technology Industries Microspec-2	E-probe with 2x2in NaI Gamma Scintillator	Gamma Spectroscopy (isotope identification)

The instrument of choice during most of the road surveys is the Ludlum Model 2221 Scaler Ratemeter with the Model 44-10 2" X 2" NaI Gamma Scintillator. Other radiological instruments are on hand if needed.

Two staff members conduct the haul road walkover survey by visually splitting the road into halves and walking in a serpentine pattern from side-to-side along the portion of road they are surveying. The NaI probe is held approximately six to twelve inches above the ground's surface as the walkover is performed.

Areas with staining of soil or stressed vegetation are noted with the Division's global positioning system (GPS) device for sampling. When an area of concern is noted, staff conducts a thorough walkover of the area and uses the GPS to locate the area of concern by latitude and longitude coordinates. Areas of concern, as well as other points, are logged to show coverage. A map of the area is printed out with points of interest and/or concerns plotted. A report is generated with the State's findings. Any concerns are brought to the attention of the Federal Facility Agreement (FFA) project managers for resolution.

References

Environmental Restoration Footprint Reduction Process Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee.

Federal Facility Agreement, January 1992 (with revisions).

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation, Oak Ridge, Tennessee. 2006.

Thomasson, D. A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Ambient Gamma Radiation Monitoring of the Oak Ridge Reservation Using Environmental Dosimetry

Introduction

Gamma radiation is emitted by various radionuclides that have been produced, stored, and disposed of on the Oak Ridge Reservation (ORR). Associated radionuclides are evident in ORR facilities and the surrounding soils, sediments, and waters. In order to assess the risk posed by these contaminants, the Tennessee Department of Environment and Conservation, DOE Oversight Division (the Division) began monitoring ambient gamma radiation levels on the ORR in 1995. The program is intended to provide

- conservative estimates of the potential dose/risk to members of the public from exposure to gamma radiation attributable to DOE activities/facilities on the ORR,
- baseline values used to assess the need/effectiveness of remedial actions,
- information necessary to establish trends in gamma radiation emissions and,
- information relative to the unplanned release of radioactive contaminants on the ORR.

In this effort, environmental dosimetry is used to measure the radiation dose attributable to external radiation at selected monitoring locations on and in the vicinity of ORR.

Methods and Materials

Dosimeters used in the program will be obtained from Landauer, Inc., Glenwood, Illinois. Each of these dosimeters will use aluminum oxide photon detectors to measure the dose from gamma radiation (minimum reporting value = 1 mrem). At locations where there is a potential for the release of neutron radiation, the dosimeters will also contain an allyl diglycol carbonate-based neutron detector (minimum reporting value = 10 mrem for thermal neutrons and 20 mrem for fast neutrons). Dosimeters that contain photon detectors alone will be collected quarterly and sent to Landauer for processing. Dosimeters that contain both photon and neutron detectors will be collected and processed semiannually, to better accommodate neutron measurements.

To account for exposures that may be received in transit or while in storage, control dosimeters will be included in each batch of dosimeters received from the Landauer Company. These dosimeters will be stored in a lead container at the division office during the monitoring period and returned to Landauer with the associated field-deployed dosimeters for processing. Any dose reported for the control dosimeters will then be subtracted from the dose reported for the field-deployed dosimeters. At the end of the year, the results will be summed for each location and the resultant annual doses compared to background values and the State/DOE primary dose limits for members of the public (100 mrem/year).

Monitoring locations will be chosen to identify sources of external radiation on the ORR, to develop conservative estimates of the dose to the public from DOE operations/facilities, and to collect information relative to the need and/or effectiveness of remediation. For 2008 Environmental Dosimetry, staff will monitor the following areas:

ORNL – Areas on ORNL lands
Spallation Neutron Source Site
Off Site areas of interest
ETTP – Areas under D & D
Y-12 – noted areas
EMWMF – Waste
Tower shielding facility

References

Federal Facility Agreement, January 1992 (with revisions).

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation, Oak Ridge, Tennessee. 2006.

Thomasson, D. A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Real Time Monitoring of Gamma Radiation on the Oak Ridge Reservation

Introduction

The Tennessee Department of Environment and Conservation, DOE Oversight Division (the Division), in association with its Ambient Gamma Radiation Monitoring Program, has deployed continuously-recording exposure-rate monitors on the Oak Ridge Reservation since 1996. These instruments record gamma radiation levels at predetermined intervals for extended periods of time. The instruments have primarily been used to monitor remedial activities and supplement the integrated dose rates provided by environmental dosimeters. In this regard, the dosimeters provide a cumulative dose over the monitoring interval, but the data do not indicate the specific time and magnitude of fluctuations in the dose rates. Consequently, a series of small releases cannot be distinguished from a single large release using the dosimeters alone. In contrast, the exposure rate monitors provide a profile of gamma emissions that can be correlated with changing environmental and/or anthropogenic conditions.

Methods and Materials

The continuous-exposure rate monitors used in the program incorporate detection equipment, power supply, software, and associated instrumentation in a portable weather resistant case. The units are capable of measuring and recording gamma exposure rates from 1 μrem/hr to 1 rem/hr at preset intervals of one minute to two hours over extended time periods (e.g., a year). The data can be downloaded in the field using an infrared transceiver, a lap top computer, and associated software.

Monitoring focuses on the measurement of exposure rates under conditions where gamma emissions are expected to fluctuate substantially over short time periods or where there is a potential for the unplanned release of gamma emitting radionuclides. The primary areas monitored in the program will be associated with remedial or waste management activities at sites where gamma radiation is known to be a concern. Sites currently monitored in the program (Figure 1) include

- the scale located at the EMWMF entrance on Bear Creek Road,
- the scale located at the Portal 6 Haul Road which leads to EMWMF,
- the 7000 area truck monitor at ORNL,
- the Molten Salt Reactor Experiment Remedial Action at ORNL,
- the TRU Waste Processing Facility in Melton Valley, and
- the background station located at Fort Loudoun Dam in Loudon County.

Monitoring stations can be expected to vary as the sites subject to remediation change and findings warrant. Additional candidates for monitoring in 2008 include the Spallation Neutron Source, the Corehole 8 Remedial Action at ORNL, and the D&D of the K-25 Building.

To evaluate the exposure rates recorded, data collected from the monitoring sites will be compared to background concentrations, to the State limits for the maximum dose to an

unrestricted area (2 mrem in any one hour period), and to the State/DOE primary dose limits for members of the public (100 mrem/year).

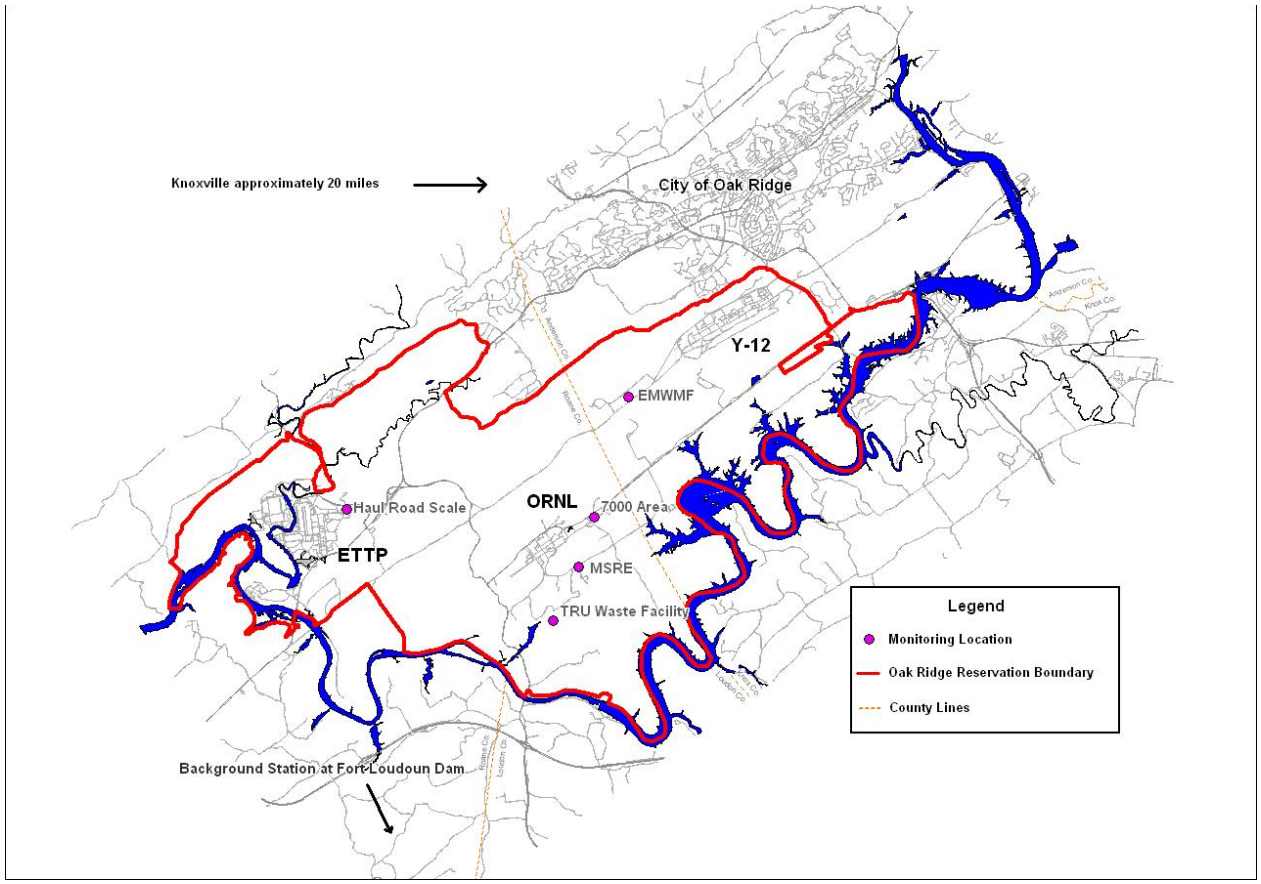

Figure 1: Current locations of real time gamma monitors on the Oak Ridge Reservation

References

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement. Agreement Between the U.S. Department of Energy and the State of Tennessee.* Oak Ridge, Tennessee. 2006.

Thomasson, D.A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Surplus Material Verification

Introduction

Since 2002, the Tennessee Department of Environment and Conservation, Department of Energy Oversight Division (the Division), in cooperation with the U.S. Department of Energy and its contractors, conducts random radiological surveys of surplus materials that are destined for sale to the public on the Oak Ridge Reservation (ORR). Standard radiological survey protocols are used for these radiological surveys. In addition to performing the surveys, the Division reviews these procedures used for release of materials under DOE radiological regulations.

Also reviewed are any occurrence reports that involve surplus materials. Some materials, such as scrap metal, may be sold to the public under annual sales contracts, whereas other materials are staged at various sites around the ORR awaiting public auction/sale. The Division, as part of its larger radiological monitoring role on the reservation, conducts these surveys to help ensure that no potentially contaminated materials reach the public. In the event that radiological activity is detected, the Division will immediately report to the responsible supervisory personnel of the surplus sales program. Division staff will follow their response to the notification, ensuring that appropriate steps (removal of items from sale, resurveys, etc.) are taken to protect the public. The Division reviews any occurrence reports, procedural changes and removal of items from sales inventories.

Methods and Materials

Staff members make random surveys of items that are arranged in sales lots by using standard survey instruments and standard survey protocols. Potential items range from furniture and computer equipment to vehicles and construction materials. Particular survey attention is paid to smaller equipment and parts. Where radiological release information is attached, radiation clearance information is compared to procedural requirements. If any contamination is detected during the on-site survey, the surplus materials manager for the facility will be notified immediately. In addition to radioactivity, any chemical concerns will be immediately brought to the attention of the manager.

References

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation, Oak Ridge, Tennessee. 2006.

Thomasson, D.A., *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division, Oak Ridge, Tennessee, 2005

SURFACE WATER MONITORING

Monitoring of Liquid Effluents at the Environmental Management Waste Management Facility

Introduction

The Tennessee Oversight Agreement requires the State of Tennessee to provide monitoring as necessary to verify DOE data and to assess the effectiveness of DOE contaminant control systems on the Oak Ridge Reservation (ORR). To this end, TDEC's Division of DOE Oversight will monitor effluents, sediments, and biota (biota is covered in a separate monitoring plan) at DOE's Environmental Management Waste Management Facility (EMWMF), located in eastern Bear Creek Valley. This facility was constructed to dispose of waste generated by remedial activities on the ORR and is operated under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). While the facility holds no permit from any state agency, it is required to comply with substantive portions of relevant and appropriate legislation contained in the CERCLA Record of Decision (DOE, 1999) and with requirements associated with responsibilities delegated to DOE by the Atomic Energy Act.

While the availability of the EMWMF has expedited remedial activities, the water-rich environment of the region presents challenges to the containment of contaminants that would not be expected in more arid areas. For example, the height of the groundwater table and the quantity of surface water runoff were apparently underestimated and the porosity of local soils was apparently overestimated in the planning stages of the facility. This resulted in repairs and/or operational modifications to maintain control of contaminant releases. One such modification triggered the excavation of a French drain under the facility to lower the water table, which had risen to levels that approached the liner of the facility.

Another modification requires the routine removal of liquids that have pooled over what should have been a porous layer emplaced to protect the leachate collection system and liner from damage during disposal operations. In the past, the pooling liquids have overflowed cell containment and discharged to the local environment. The liquid, a mixture of rainwater runoff and drainage from the waste, is now pumped to holding ponds, where it is sampled and then sent to treatment or released to a ditch that empties into a sediment basin. The sediment basin discharges to a local tributary of Bear Creek (NT-5). It is the intent of the project to verify that effluents from the facility and associated contaminant control mechanisms are consistent with criteria agreed to by the State, EPA, and DOE.

Methods and Materials

Monitoring locations are depicted in Figure 1 and descriptions of the sampling points are provided below. (NT-# designates a numbered north tributary.)

- EMWMF 1: The background location (i.e. Catty Wampus Spring) located upslope of the facility at the headwaters of NT-4. The major portion of the NT-4 channel was filled and associated waters diverted to NT-5 to accommodate construction of EMWMF.

- EMWMF 2: Discharge from a French drain emplaced under the facility to prevent groundwater from encroaching on the liner. This location is also referred to as the underdrain.
- EMWMF 3: The sediment basin at the outfall leading to NT-5.
- EMWMF 4: An unlined drain receiving storm water runoff from cells that are designated as inactive, but may contain stored materials assumed to be waste or are next to active waste cells.
- EMWMF 5: An unlined ditch used to transfer effluents from the holding ponds to the sediment basin. The effluents in the ponds consist of liquids and suspended materials that accumulate at the lower end of the active cell over the problematic protective soil cover.
- Other locations as merited.

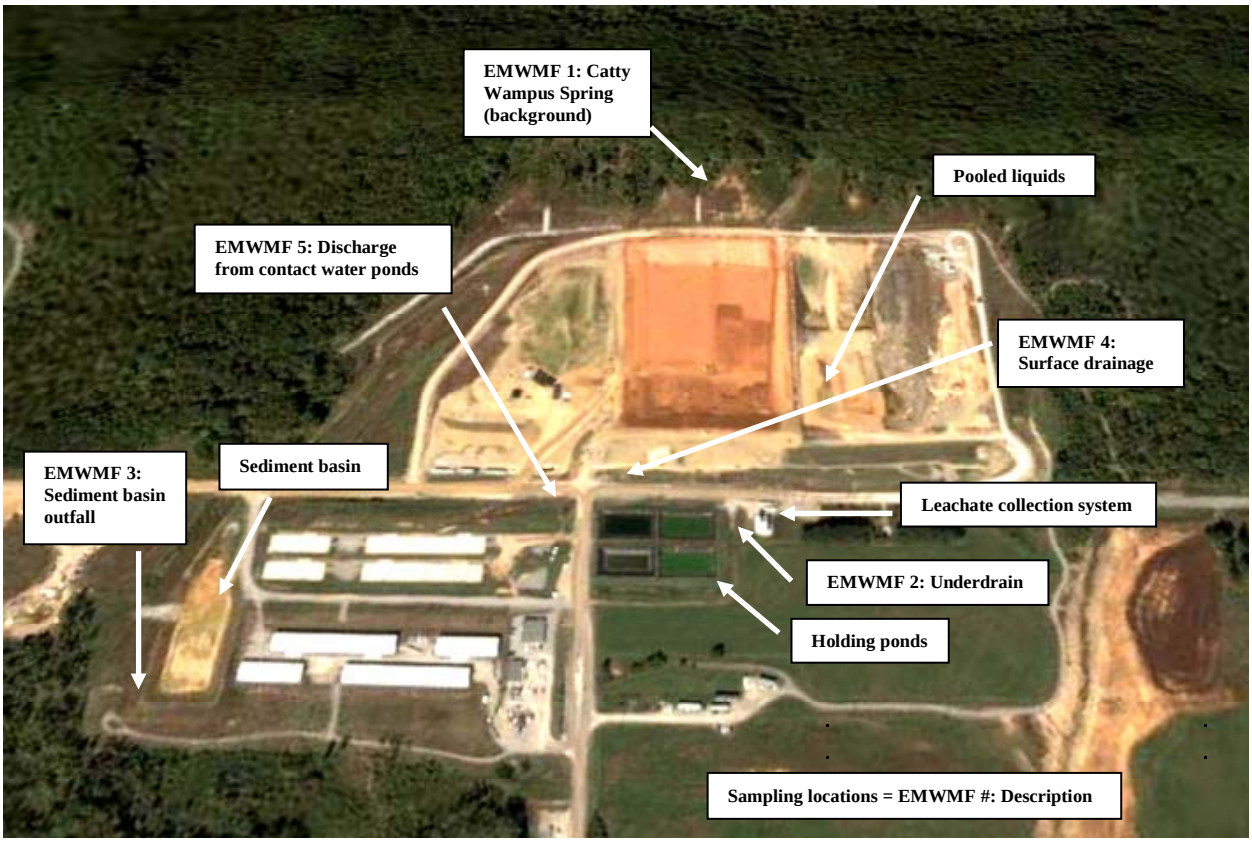

Figure 1: Sampling Locations at the Environmental Management Waste Management Facility

The media sampled will include effluents and associated sediments. The analyses will vary based on the media being sampled, previous findings, and the particular wastes being disposed of at EMWMF. Gross analysis will be used to screen for alpha and beta emitters, with more specific analyses performed in response to elevated results. Since monitoring for all radionuclides disposed of in the facility would be cost prohibitive, efforts will focus specific analyses on the

more mobile species (e.g. tritium and technetium-99), contaminants previously detected in effluents and especially those indicated from gross analysis of alpha and beta emitters (e.g. uranium isotopes and strontium-90), as well as radionuclides that would not be evident in gross measurements (e.g. tritium and carbon-14). Gamma spectrometry will be used to identify gamma emitters (e.g. cesium-137).

Sampling frequencies will depend on conditions and activities at the site. In general, concentrations of contaminants will fluctuate as site conditions change. The weather (precipitation), operational activities (pumping effluents from the holding ponds), and contaminants in the waste being disposed of, each effect contaminant concentrations. Consequently, samples will be taken as conditions merit with the intent to monitor waste streams under different conditions in order to characterize and delineate contaminant releases.

References

Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, DOE/OR/01-1791&D3, U.S. Department of Energy, *Oak Ridge, Tennessee*. November 1999.

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation, Oak Ridge, Tennessee. 2006.

Thomason, D. A. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Rain Event Surface Water Monitoring

Introduction

Heavy rainfall events have the capability of transporting significant quantities of contaminants, which would normally remain in place, into nearby bodies of water. This mass transport can, in turn, impact the quality of the receiving waters. Due to the presence of areas of extensive point and non-point source contamination on the Oak Ridge Reservation (ORR), there exists the potential for contamination to impact surface waters on the ORR during excessive rain events. These events could cause the displacement of contamination that would not normally impact streams around the ORR.

To assess the degree of surface water impact caused by these rain events, a sampling of streams will be conducted following heavy rain events to determine the presence or absence of contaminants of concern. Table 1 shows locations that have been selected for sampling.

Table 1: Sample Locations

Site	Location
EFK 23.4	Station 17
WCK 3.0	White Oak Creek at Lagoon Road
MEK 0.1	Melton Branch Weir*
MIK 0.1	Mitchell Branch Weir
BCK 4.5	Bear Creek Weir at Hwy. 95
MBK 1.6	Mill Branch (Reference)

*an engineered structure that simplifies water flow measurement

Methods and Materials

In addition to temperature, pH, and conductivity, the following parameters will be measured:

Inorganics: arsenic, cadmium, chromium, hexavalent chromium (MIK 0.1 only), copper, iron, lead, manganese, mercury, zinc, nitrogen (NO_2 & NO_3), ammonia, nitrogen (total Kjeldahl), total phosphates, sulfates (EFK 23.4 only).

Other tests: E. coli, Enterococcus, dissolved residue, suspended residue, and total hardness.

Radionuclides: Gross alpha, gross beta, gamma radionuclides, and strontium-90 (MEK 0.1 only).

Schedule

The monitoring will be conducted no more than once per quarter following either a one-inch rain event in a 24-hour period or a two-inch rain event over a 72-hour period.

Standard Operating Procedures
Special care must be taken when sampling water in which contaminants can be detected in the parts-per-billion and/or parts-per-trillion ranges. In order to prevent cross-contamination of these samples, the following precautions shall be taken when trace contaminants are of concern.

- A clean pair of new, non-powdered, disposable latex or vinyl gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come into contact with the media being sampled.

- Sample containers for source samples, or for samples suspected of containing high concentrations of contaminants, should be placed in separate plastic bags immediately after collecting, tagging, etc.

- If possible, different field teams should collect ambient samples and source samples. If different field teams cannot be used, all ambient samples shall be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly-contaminated samples shall never be placed in the same ice chest as environmental samples. Ice chests or shipping containers for source samples, or samples suspected to contain high concentrations of contaminants, should be lined with new, clean, plastic bags.

- If possible, one member of the field sampling team should take all the notes, fill out tags, etc., while the other member(s) collect the samples.

- When sampling surface waters, the water sample should always be collected before the sediment sample is collected.

- Sample collection activities should proceed progressively from the least suspected contaminated area to the most suspected contaminated area.

- Investigators should use equipment constructed of Teflon®, stainless steel, or glass that has been properly pre-cleaned when collecting samples for trace metals or organic compound analyses. Teflon® or glass is preferred where trace metals are of concern.

Sample Handling
After collection, all sample handling should be minimized. Investigators should use extreme care to ensure that samples are not contaminated. If samples are placed in an ice chest, investigators should ensure that melted ice cannot cause the sample containers to become submerged, as this may result in sample cross-contamination. Plastic bags, such as zip-lock bags or similar plastic bags sealed with tape, should be used when small sample containers (e.g., VOC vials or bacterial samples) are placed in ice chests. This will prevent cross-contamination.

Laboratory Services Procedures
Laboratory Services has expertise in a broad scope of services and analyses. This expertise is

available to the Tennessee Department of Environment and Conservation, Department of Energy Oversight Division (the Division) and other TDEC divisions statewide. General sampling and analysis methods will follow Environmental Protection Agency (EPA) guidelines as listed in appropriate parts of *Title 40 Code of Federal Regulations* (CFR). Laboratory Services may subcontract certain analyses and QC samples out to independent laboratories. Bench level quality assurance/quality control (QA/QC) records and chain-of-custody records are maintained at Laboratory Services, as are QA records on subcontracted samples.

The Division will primarily use the Knoxville branch of Laboratory Services. Wet chemistry and metals samples will be analyzed in Knoxville, while organics samples will be sent to Laboratory Services in Nashville. All Laboratory Services analyses will follow appropriate methods as documented in the Laboratory Services Inorganic Chemistry SOP and Organic Chemistry SOP. Specific analytical methods are covered in the Standard Operating Procedures (SOP) manuals for Laboratory Services. The SOPs direct analysts to the proper EPA or other methodology.

References

Environmental Compliance Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region IV, Environmental Services Division, Atlanta, Georgia. 1991.

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region IV, 960 College Station Road, Athens, Georgia. 1996.

Standard Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing, E 1391-90, American Society for Testing and Materials, Philadelphia, PA. 1990.

Standard Operating Procedures, Tennessee Department of Health Laboratory Services, Nashville, Tennessee, 1999

The Status of Water Quality in Tennessee: Technical Report, Tennessee Department of Environment and Conservation, Division of Water Pollution Control. Nashville, Tennessee. 1998.

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation. Oak Ridge, Tennessee. 2006.

Thomasson, D. A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation, Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Ambient Sediment Monitoring Program

Introduction

Sediment samples are collected annually at sites on the Clinch River and some of its tributaries. The sediment samples are analyzed for organics, metals, and radiological contamination in order to assess the sediment quality for public health and ecological considerations.

The objective of this monitoring program is to assess the degree of sediment pollution of the Clinch River and its tributaries.

Sample Locations

Site	Location	Clinch River Mile*
2	Clinch River	52.6
3	Clinch River	35.5
4	Clinch River	17.9
5	Clinch River	10.1
6	Clinch River	48.7
7	Clinch River	41.2
8	Scarboro Creek (SCM 0.1)	41.2
9	Kerr Hollow Branch (KHM 0.1)	41.2
10	McCoy Branch (MCM 0.1)	37.5
12	East Fork Walker Branch (EFWM 0.1)	33.2
13	Bearden Creek (BCM 0.1)	31.8
18	Raccoon Creek (RCM 0.1)	19.5
20	Grassy Creek (GCM 0.1)	14.55
22	Unnamed stream (U22M 0.1)	14.45
23	Ernie's Creek (ECM 0.1)	51.1
24	White Creek (WCM 0.1)	102.4
25	Clear Creek (CCM 0.1)	78.2
27	Clinch River	7.0
28	Clinch River	4.0
29	Clinch River Mouth	0.0
32	Clinch River	19.7
33	Poplar Creek (PCM 1.0)	12.0
36	Poplar Creek (PCM 2.2)	12.0
37	Poplar Creek (PCM 3.5)	12.0
38	Poplar Creek (PCM 5.5)	12.0

*Clinch River Mile Column refers to location of stream mouth for tributaries.

Methods and Materials

Parameters to be analyzed:
Inorganics: aluminum, arsenic, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, and zinc

Organics (extractables): butylbenzylphthalate, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, di-n-octylphthalate, diethylphthalate, dimethylphthalate, n-nitrosodimethylamine, n-

nitrosodiphenylamine, n-nitroso-di-n-propylamine, isophorone, nitrobenzene, 2,4-dinitrotoluene, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene, bis(2-chloroethyl) ether, bis(2-chloroethoxy)methane, bis(2-chloroisopropyl) ether, 4-bromophenylphenyl ether, 4-chlorophenylphenylether, hexachlorocyclopentadiene, hexachlorobutadiene, hexachlorobenzene, hexachloroethane, 1,2,4-trichlorobenzene, 2-chloronapthalene, 4-chloro-3-methyl phenol, 2-chlorophenol, 2,4-dichlorophenol, 2,4-dimethylphenol, 4,6-dinitro-o-cresol, 2-nitrophenol, 4-nitrophenol, pentachlorophenol, phenol, 2,4,6-trichlorophenol

Organics (pesticides/PCBs): aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC (lindane), technical chlordane, alpha-chlordane, gamma-chlordane, 4,4-DDD, 4,4-DDE, 4,4-DDT, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, endrin ketone, heptachlor, heptachlor epoxide, toxaphene, methoxychlor, PCB 1016/1242, PCB 1221, PCB 1232, PCB 1248, PCB 1254, PCB 1260, PCB 1262

Radiological: gross alpha (total), gross beta (total), gross gamma (total), *gamma radionuclides:* ^{137}Cs, ^{40}K, ^{214}Pb, ^{214}Bi, ^{212}Pb, ^{228}Ac, ^{208}Tl, ^{212}Bi and others as detected.

Toxicity: Hyalella azteca 10-day sediment acute toxicity tests for impacted sites (10 samples)

Schedule
The ambient sediment monitoring will be conducted in the second quarter of 2008.

Sediment Standard Operating Procedures
Sediment analysis is a key component of environmental quality and impact assessment for rivers, streams, lakes, and impoundments. Samples can be collected for a variety of chemical, physical, toxicological and biological investigations. This procedure is to be used to obtain quality assured sediment sampling. The resulting data may be qualitative or quantitative in nature and is appropriate for use in preliminary surveys as well as confirmatory sampling.

Required Equipment
sampling platform/boat
depth finder
stainless steel petite ponar grab sampler
stainless steel mixing bowl
stainless steel spoon
pressurized water sprayer
deionized water
rubber gloves
aluminum foil
sample jars
sample labels
cooler/ice packs
scrubber
lab sheets
chain-of-custody forms
field notebook

Procedure
If the water is wadeable, one can collect a sediment sample by scooping the sediment using a stainless steel spoon or scoop. This can be accomplished by wading into the stream, and while facing upstream, scooping the sample along the stream bottom in the upstream direction. If one is sampling a deep lake or impoundment, one can use the Petite Ponar dredge to obtain a sample. Step by step directions are as follows.

Sediment sampling in wadeable streams and rivers

1. Locate suitable sampling site. Remember that a site immediately downstream of a riffle area has the greatest amount of deposition since the velocity of the stream slows down. Beware of constrictions in the stream where scouring may be occurring.
2. Don rubber gloves to avoid self-contamination and/or cross-contamination during sampling.
3. Using decontaminated stainless steel spoon, obtain sediment sample by scraping the streambed.
4. Place sufficient amount of sediment in a stainless steel bowl and mix thoroughly to obtain a homogeneous sample.
5. Carefully transfer sample into the appropriate containers as stated by the State of Tennessee Labs.
6. Record all pertinent information on lab sheets, sample labels, and make necessary entries into field notebook.
7. Place all samples into cooler as soon as possible. Temperature within the cooler should be maintained at 4° C by using ice or freezer packs.
8. Deliver sediment samples to State lab within appropriate holding time frames, and sign chain of custody forms.

Sediment sampling in lakes or reservoirs using Petite Ponar dredge

1. Don rubber gloves to avoid self-contamination during sediment sampling.
2. Place stabilizing pin into arm attachments to lock dredge jaws in open position.
3. Using dredge cable, carefully lower dredge through water column. Slow the descent just prior to contact with sediment to prevent any disturbance to the sediment.
4. As the dredge contacts the sediment, allow the line to go slack, which in turn releases the stabilizing pin.
5. Give a quick tug to the cable; this enables the dredge jaws to close. Carefully pull the dredge through the water column.
6. Repeat step 5 until sufficient sediment has been obtained, placing sediment into a stainless steel bowl.
7. Thoroughly mix the sediment with a stainless steel spoon to obtain a homogeneous composite.
8. Carefully transfer the collected sediment into appropriate sampling jars as stated by the State of Tennessee Labs.
9. Record all pertinent information on lab sheets, samples labels, and make necessary entries into field notebook.
10. Place sediment samples into cooler as soon as possible. Temperature within the cooler should be maintained at 4° C by using ice or freezer packs.
11. Deliver samples to State lab within appropriate time frames. Be sure to sign all chain of custody forms.

Laboratory Procedures

The Tennessee Department of Health, Environmental Laboratory and Microbiological Laboratory Organization (Laboratory Services) has expertise in a broad scope of services and analysis available to the Tennessee Department of Environment and Conservation (TDEC)

Department of Energy Oversight (DOE-O) and other TDEC divisions statewide. General sampling and analysis methods are to follow Environmental Protection Agency (EPA) guidelines as listed in appropriate parts of *Title 40, Code of Federal Regulations* (CFR). Laboratory Services may subcontract certain analyses and QC samples out to independent laboratories. Bench level Quality Assurance/Quality Control (QA/QC) records and chain-of-custody records are maintained at the Tennessee Environmental Laboratory, as are QA records on subcontracted samples.

DOE-O will primarily use the Knoxville branch of Laboratory Services. Wet chemistry and metals samples will generally be analyzed in Knoxville while organics samples will be sent on to the Central Laboratory in Nashville. All laboratory analysis will follow appropriate methods as documented in the Laboratory Services Inorganic Chemistry SOP and Organic Chemistry SOP. Specific analytical methods are covered in the Standard Operating Procedures (SOP) manuals for the Tennessee Laboratory Services Division. The SOPs direct analysts to the proper EPA or other methodology.

References

Tennessee Department of Environment and Conservation Department of Energy Oversight. *Standard Operating Procedures.* Oak Ridge, Tennessee 1996.

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement. Agreement Between the U.S. Department of Energy and the State of Tennessee.* Oak Ridge, Tennessee. 2006.

Thomasson, D. A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

U. S. Environmental Protection Agency. *Environmental Compliance Standard Operating Procedures and Quality Assurance Manual*, U.S. Environmental Protection Agency, Region 4, Environmental Services Division. Atlanta, Georgia. 1991.

U.S. Environmental Protection Agency. *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual*, EPA 823-B-01-002, U.S. Environmental Protection Agency, Office of Water. Washington, DC. 2001.

Ambient Surface Water Monitoring Program

Introduction

Surface water sampling is conducted twice a year at 20 sites located on the Clinch River and its tributaries. The surface water samples are analyzed for radiological activity, metals, nutrients and other parameters in order to assess the water quality for public health and ecological considerations. Sampling sites 1, 2, 24, and 25 are background data collection sites and are located upstream of the Oak Ridge Reservation (ORR). The other sites were chosen to detect contaminants being transported by surface water or stormwater coming from the ORR or areas affected by Department of Energy (DOE) related activities. TDEC personnel collect tributary samples far enough upstream such that high river levels do not compromise the sample.

Sample Locations

Site	Location	Clinch River Mile*
1	Clinch River	78.7
2	Clinch River	52.6
3	Clinch River	35.5
4	Clinch River	17.9
5	Clinch River	10.1
6	Clinch River	48.7
7	Clinch River	41.2
8	Scarboro Creek (SCM 0.1)	41.2
9	Kerr Hollow Branch (KHM 0.1)	41.2
10	McCoy Branch (MCM 0.1)	37.5
12	East Fork Walker Branch (EFWM 0.1)	33.2
13	Bearden Creek (BCM 0.1)	31.8
18	Raccoon Creek (RCM 0.1)	19.5
20	Grassy Creek (GCM 0.1)	14.55
22	Unnamed Stream (U22M 0.1)	14.45
23	Ernie's Creek (ECM 0.1)	51.1
24	White Creek (WCM 0.1)	102.4
25	Clear Creek (CCM 0.1)	77.7
32	Clinch River	19.7
33	Poplar Creek (PCM 1.0)	12.0

*For tributaries, the Clinch River Mile column refers to the mouth of the tributary.

Methods and Materials

Parameters to be analyzed:

Inorganics: arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, zinc, nitrogen (NO_2 & NO_3), ammonia, nitrogen (total Kjeldahl), total phosphorus.

Other tests: E. coli, *Enterococcus*, COD, dissolved residue, suspended residue, total hardness.

Schedule
The ambient water monitoring will be conducted in the second and fourth quarters.

Standard Operating Procedures
Special care must be taken when sampling water in which contaminants can be detected in the parts-per-billion and/or parts-per-trillion ranges. In order to prevent cross-contamination of these samples, the following precautions shall be taken when trace contaminants are of concern.

- A clean pair of new, non-powdered, disposable vinyl gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come into contact with the media being sampled.

- Sample containers for source samples or samples suspected of containing high concentrations of contaminants should be placed in separate plastic bags immediately after collecting, tagging, etc.

- If possible, one member of the field sampling team should take all the notes, fill out tags, etc., while the other member(s) collect the samples.

- When sampling surface waters, the water sample should always be collected before the sediment sample is collected.

- Sample collection activities should proceed progressively from the least suspected contaminated area to the most suspected contaminated area.

- Investigators should use equipment constructed of Teflon®, stainless steel, or glass that has been properly precleaned for collection of samples for trace metals or organic compounds analyses. Teflon or glass is preferred for collecting samples where trace metals are of concern. Equipment constructed of plastic or PVC shall <u>not</u> be used to collect samples for trace organic compounds analyses.

Sample Handling
After collection, all sample handling should be minimized. Investigators should use extreme care to ensure that samples are not contaminated. If samples are placed in an ice chest, investigators should ensure that melted ice cannot cause the sample containers to become submerged, as this may result in sample cross-contamination. Plastic bags, such as Zip-Lock® bags or similar plastic bags sealed with tape, should be used when small sample containers (e.g., VOC vials or bacterial samples) are placed in ice chests to prevent cross-contamination.

Laboratory Procedures
The Tennessee Department of Health, Environmental Laboratory and Microbiological Laboratory Organization (Laboratory Services) has expertise in a broad scope of services and analysis available to the Tennessee Department of Environment and Conservation (TDEC) Department of Energy Oversight (DOE-O) and other TDEC divisions statewide. General sampling and analysis methods are to follow Environmental Protection Agency (EPA) guidelines

as listed in appropriate parts of *Title 40, Code of Federal Regulations* (CFR). Laboratory Services may subcontract certain analyses and QC samples out to independent laboratories. Bench level Quality Assurance/Quality Control (QA/QC) records and chain-of-custody records are maintained at the Tennessee Environmental Laboratory, as are QA records on subcontracted samples.

DOE-O will primarily use the Knoxville branch of Laboratory Services. Wet chemistry and metals samples will generally be analyzed in Knoxville while organics samples will be sent on to the Central Laboratory in Nashville. All laboratory analysis will follow appropriate methods as documented in the Laboratory Services Inorganic Chemistry SOP and Organic Chemistry SOP. Specific analytical methods are covered in the Standard Operating Procedures (SOP) manuals for the Tennessee Laboratory Services Division. The SOPs direct analysts to the proper EPA or other methodology.

References

American Society for Testing and Materials. *Standard Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing*, E 1391-90, American Society for Testing and Materials, Philadelphia, PA, 1990.

Tennessee Department of Health Laboratory Services. *Standard Operating Procedures.* Tennessee Department of Health Laboratory Services. Nashville, Tennessee. 1999.

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement. Agreement Between the U.S. Department of Energy and the State of Tennessee*. Oak Ridge, Tennessee. 2006.

Thomasson, D. A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

U.S. Environmental Protection Agency. *Environmental Compliance Standard Operating Procedures and Quality Assurance Manual*, U.S. Environmental Protection Agency, Region 4, Environmental Services Division, Atlanta, GA, 1991.

U.S. Environmental Protection Agency. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual,* U.S. Environmental Protection Agency, Region 4, 960 College Station Road, Athens, GA, 1996.

Surface Water (Physical Parameters) Environmental Monitoring Plan

Introduction

Due to the presence of areas of extensive point and non-point source contamination on the Oak Ridge Reservation (ORR), there exists the potential for contamination to impact surface waters on the ORR. These events could cause the displacement of contamination that would not normally impact streams around the ORR.

To assess the degree of surface water impact relative to this potential contamination displacement, real time stream monitoring data will be collected twice a week during 2008 from a sitewide network of primary ambient monitoring stations to establish a database of physical stream parameters (i.e., conductivity, pH, temperature, dissolved oxygen, etc.). Watersheds to be monitored include East Fork Poplar Creek, Bear Creek and Mitchell Branch. The primary objective of this monitoring project is to provide supplementary water quality data for division programs and organizations outside of TDEC. Furthermore, this monitoring task is directed toward determining long-term water quality trends, assessing attainment of water quality standards and providing additional baseline data for evaluating stream recovery. Table 1 is a list of eight monitoring sites that have been selected for data collection.

Table 1. Sample Locations

Site	Location
EFK 23.4	Station 17
EFK 13.8	Oak Ridge Sewage Treatment Plant
BCK 4.5	Bear Creek Weir at Hwy. 95
BCK 9.0 (New Weir)	Bear Creek Monitoring Location
BCK 9.6	Bear Creek Monitoring Location
BCK 12.3	Bear Creek Monitoring Location
MIK 0.1	Mitchell Branch Weir
MBK 1.6	Mill Branch (Reference)

Methods and Materials

Surface water physical parameters to be collected semiweekly at the seven sites include: dissolved oxygen (DO), pH, temperature and conductivity. The three watersheds to be monitored include two sites at Mitchell Branch watershed (East Tennessee Technology Park), two sites at East Fork Poplar Creek watershed (Y-12 National Security Complex), and four sites at Bear Creek watershed (Y-12 National Security Complex).

Ideally, data will be collected twice a month at each of the monitoring stations listed in Table 1. It is estimated that approximately three hours per field trip will be required to collect data at all seven monitoring sites.

The instrument to be used for the project is the Horiba U-10® Water Quality Checker (LCD readout). This state-of-the-art hand-held instrument is used for simultaneous multi-parameter measurement of water quality and measures pH, conductivity, turbidity, dissolved oxygen,

temperature, and salinity. The instrument consists of a probe unit (with various sensors) attached to a handheld unit (LCD readout & keypad) via a 3-foot cable. Measurements are taken simply by immersing the probe directly into the creek, pond, or river, and parameter readings can then be recorded from the hand-held unit LCD readout (one parameter at a time is displayed and is initialized using the keypad).

In the event real-time field readings such as pH and conductivity are beyond benchmark ranges, then the following action will be taken. First, wait 24 hours, re-calibrate Horiba™ instrument, and re-take physical parameter readings. Secondly, if readings are still deviant, investigate possible causes (e.g., defective equipment, storm surge/rain events, releases that may have affected pH, etc.). Thirdly, following investigation, report findings to appropriate program(s) within the Division to determine further action, if needed.

Standard Operating Procedures

Special care must be taken when monitoring water in which contaminants can be detected in the parts per billion and/or parts per trillion ranges. Also, proper maintenance and care of the Horiba U-10 instrument is essential. The instrument should be recalibrated regularly. In order to prevent or minimize cross-contamination and to extend the life of the monitoring instrument, the following precautions are recommended as QA/QC procedures.

- The Horiba U-10 instrument should be recalibrated prior to going to field each week, and this data logged into the laboratory notebook.
- After instrument readings have been recorded at each monitoring station, the instrument probe should be rinsed and cleaned with deionized water (three times) before being used at the next monitoring site.
- The instrument probe parts should be thoroughly rinsed and cleaned prior to storage (after returning from each field outing). The Horiba U-10 owners manual specifies that the pH sensor must always be kept moist during long term storage; also, remove the battery from the main unit prior to long term storage.
- If possible, one member of the field sampling team should take all the notes, fill out forms, etc., while the other member(s) collects the field data using the Horiba U-10 instrument.
- Sample collection activities should proceed progressively from the least suspected contaminated area to the most suspected contaminated area.

Sample Handling

No water quality samples will be collected during this project.

References

Horiba. *Horiba Water Quality Checker: Model U-10 Instruction Manual*. 2nd edition. Horiba, Ltd., Miyanohigashi, Kisshoin, Minami-ku, Kyoto, Japan. November 1991.

Tennessee Department of Environment and Conservation. *The Status of Water Quality in Tennessee: Technical Report.* Division of Water Pollution Control, Tennessee Department of Environment and Conservation. Nashville, Tennessee. 1998.

Thomasson, D. A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

Ambient Trapped Sediment Monitoring Program

Introduction

Sediment samples will be collected with sediment traps at sites on the Clinch River and some tributaries. The sediment samples will be analyzed for metals and radiological contamination. The objective of this monitoring program is to assess the sediment that is being currently deposited in the Clinch River and some of its tributaries.

Sample Locations

Location	Latitude	Longitude
Clinch River Mile 48.7	N 36.02445°	W 84.16720°
Clinch River Mile 37.2	N 35.95167°	W 84.24833°
Clinch River Mile 19.7	N 35.90006°	W 84.34956°
Clinch River Mile 15	N 35.89554°	W 84.38748°
Clinch River Mile 10.1	N 35.92022°	W 84.43397°
Poplar Creek Mile 0.1	N 35.92369°	W 84.40790°
McCoy Branch Mile 0.1	N 35.96587°	W 84.24823°

Methods and Materials

Parameters to be analyzed:
Inorganics: aluminum, arsenic, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, and zinc.

Radiological: gross alpha (total), gross beta (total), gross gamma (total), *gamma radionuclides:* ^{137}Cs, ^{40}K, ^{214}Pb, ^{214}Bi, ^{212}Pb, ^{228}Ac, ^{208}Tl, ^{212}Bi and others as detected.

Schedule
The ambient trapped sediment monitoring will be conducted throughout the year. Traps will be placed and checked periodically to assess the rate of sediment deposition. Different sites are expected to have different rates of deposition. It may take as long as a year to accumulate enough sediment (10 grams dry weight) to be analyzed depending on rates of sediment deposition.

Sediment Standard Operating Procedures
Sediment analysis is a key component of environmental quality and impact assessment for rivers, streams, lakes, and impoundments. Samples can be collected for a variety of chemical, physical, toxicological and biological investigations. This procedure is to be used to obtain quality assured sediment sampling. The resulting data may be qualitative or quantitative in nature and is appropriate for use in preliminary surveys as well as confirmatory sampling.

Required Equipment
boat
depth finder
sediment traps
aluminum foil
sample jars
sample labels

stainless steel mixing bowl
stainless steel spoon
pressurized water sprayer
deionized water
rubber gloves
cooler/ice packs
scrubber
lab sheets
chain-of-custody forms
field notebook

Procedure

In the Clinch River sediment traps will be lowered from the boat into a suitable location on the river bottom and secured with a discretely placed wire cable to a tree or tree root on the bank. Tributary sediment traps will be placed by wading into the stream and positioning the sediment trap in a suitable location. Step by step directions are as follows.

Sediment trap sampling in streams

1. Locate a sampling site that is suitable for sediment deposition (low velocity and water pressure).
2. Don rubber gloves to avoid self-contamination and/or cross-contamination during sampling.
3. Position the trap on the bottom; rocks or other objects may be used to weigh it down. Secure the trap to the bank with a steel cable or rope. Care should be used to minimize effects on flow by the weights.
4. Check the trap quarterly and collect the sediment. Carefully transfer sample into the appropriate containers as stated by the State of Tennessee Labs.
5. Record all pertinent information on lab sheets, sample labels, and make necessary entries into field notebook.
6. Place all samples into cooler as soon as possible. Temperature within the cooler should be maintained at 4° C by using ice or freezer packs.
7. Rinse all equipment using scrubber brush and sprayer filled with deionized water.
8. Deliver sediment samples to State lab within appropriate holding time frames, and sign chain-of-custody forms.

Sediment sampling in lakes or reservoirs

1. Don rubber gloves to avoid self-contamination and/or cross-contamination during sediment sampling.
2. Lower the sediment trap into a suitable location slowly after securing weights to the trap.
3. Secure the trap to the shore discretely with steel cable attached to roots, tree trunks, rocks, etc.
4. Check the trap quarterly and collect the sediment. Carefully transfer the collected sediment into appropriate sampling jars as stated by the State of Tennessee Labs.
5. Record all pertinent information on lab sheets, samples labels, and make necessary entries into field notebook.
6. Place sediment samples into cooler as soon as possible. Temperature within the cooler should be maintained at 4° C by using ice or freezer packs.
7. Rinse all equipment using scrubber brush and sprayer filled with deionized water.
8. Deliver samples to State lab within appropriate time frames. Be sure to sign all chain-of-custody forms.

Laboratory Procedures

The Tennessee Department of Health, Environmental Laboratory and Microbiological Laboratory Organization (Laboratory Services) has expertise in a broad scope of services and analysis available to the Tennessee Department of Environment and Conservation (TDEC) Department of Energy Oversight (DOE-O) and other TDEC divisions statewide. General sampling and analysis methods are to follow Environmental Protection Agency (EPA) guidelines as listed in appropriate parts of *Title 40, Code of Federal Regulations* (CFR). Certain analyses and QC samples may be subcontracted out by Laboratory Services to independent laboratories. Bench level Quality Assurance/Quality Control (QA/QC) records and chain-of-custody records are maintained at the Tennessee Environmental Laboratory as are QA records on subcontracted samples.

DOE-O will primarily use the Knoxville branch of Laboratory Services. Wet chemistry and metals samples will generally be analyzed in Knoxville while organics samples will be sent on to the Central Laboratory in Nashville. All laboratory analysis will follow appropriate methods as documented in the Laboratory Services Inorganic Chemistry SOP and Organic Chemistry SOP. Specific analytical methods are covered in the Standard Operating Procedures (SOP) manuals for the Tennessee Laboratory Services Division. The SOPs direct analysts to the proper EPA or other methodology.

References

Tennessee Department of Environment and Conservation Department of Energy Oversight. *Standard Operating Procedures.* Oak Ridge, Tennessee 1996.

Tennessee Department of Health Laboratory Services. *Standard Operating Procedures.* Tennessee Department of Health Laboratory Services. Nashville, Tennessee. 1999.

Thomasson, D. A. *Health, Safety, and Security Plan.* Tennessee Department of Environment and Conservation Department of Energy Oversight Division. Oak Ridge, Tennessee. 2005.

U. S. Environmental Protection Agency. *Environmental Compliance Standard Operating Procedures and Quality Assurance Manual*, U.S. Environmental Protection Agency, Region 4, Environmental Services Division. Atlanta, Georgia. 1991.

U. S. Environmental Protection Agency. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, U. S. Environmental Protection Agency, Region 4. Enforcement and Investigations Branch. Athens, Georgia. 1997. *(EISOPQAM).*

U.S. Environmental Protection Agency. *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual*, EPA 823-B-01-002, U.S. Environmental Protection Agency, Office of Water. Washington, DC. 2001.

APPENDIX A

LIST OF COMMON ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
ASER	Annual Site Environmental Report (written by DOE)
ASTM	American Society for Testing and Materials
BCK	Bear Creek Kilometer (station location)
BFK	Brushy Fork Creek Kilometer (station location)
BJC	Bechtel Jacobs Company
BMAP	Biological Monitoring and Abatement Program
BNFL	British Nuclear Fuels Limited
BOD	Biological Oxygen Demand
BWXT	Y-12 Prime Contractor (current)
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAP	Citizens Advisory Panel (of LOC)
CCR	Consumer Confidence Report
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	Contaminants of Concern
COD	Chemical Oxygen Demand
CPM (cpm)	Counts per Minute
CRM	Clinch River Mile
CROET	Community Reuse Organization of East Tennessee
CWA	Clean Water Act
CYRTF	Coal Yard Runoff Treatment Facility (at ORNL)
D&D	Decontamination and Decommissioning
DCG	Derived Concentration Guide
DOE	Department of Energy
DOE-O	Department of Energy-Oversight Division (TDEC)
DWS	Division of Water Supply (TDEC)
E. coli	*Escherichia coli*
EAC	Environmental Assistance Center (TDEC)
ED1, ED2, ED3	Economic Development Parcel 1, Parcel 2, and Parcel 3
EFPC	East Fork Poplar Creek
EMC	Environmental Monitoring and Compliance (DOE-O Program)
EMWMF	Environmental Management Waste Management Facility
EPA	Environmental Protection Agency
EPT	*Ephemeroptera, Plecoptera, Trichoptera* (may flies, stone flies, caddis flies)
ET&I	Equipment Test and Inspection
ETTP	East Tennessee Technology Park
FDA	U.S. Food and Drug Administration
FFA	Federal Facilities Agreement

FRMAC	Federal Radiation Monitoring and Assessment Center
g	Gram
GHK	Gum Hollow Branch Kilometer (station location)
GIS	Geographic Information Systems
GPS	Global Positioning System
GW	Ground Water
GWQC	Ground Water Quality Criteria
HAP	Hazardous Air Pollutant
HCK	Hinds Creek Kilometer (station location)
IBI	Index of Biotic Integrity
IC	In Compliance
"ISCO" Sampler	Automatic Water Sampler
IWQP	Integrated Water Quality Program
K-####	Facility at K-25 (ETTP)
K-25	Oak Ridge Gaseous Diffusion Plant (now called ETTP)
KBL	Knoxville Branch Laboratory
KFO	Knoxville Field Office
l	Liter
LC_{50}	Lethal Concentration at which 50 % of Test Organisms Die
LMES	Lockheed Martin Energy Systems (past DOE Contractor)
LOC	Local Oversight Committee
LWBR	Lower Watts Bar Reservoir
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MACT	Maximum Achievable Control Technologies
MBK	Mill Branch Kilometer (station location)
MCL	Maximum Contaminant Level (for drinking water)
MDC	Minimum Detectable Concentration
MEK	Melton Branch Kilometer (station location)
µg	Microgram
mg	Milligram
MIK	Mitchell Branch Kilometer (station location)
ml	Milliliter
MMES	Martin Marietta Energy Systems (past DOE Contractor)
m	Meter
µmho	Micro mho (mho=1/ohm)
MOU	Memorandum of Understanding
µR	Microroentgen
Mrem	1/1000 of a rem – millirem
N, S, E, W	North, South, East, West
NAAQS	National Ambient Air Quality Standards
NAREL	National Air and Radiation Environmental Laboratory
NAT	No Acute Toxicity
NEPA	National Environmental Policy Act
NIC	Not In Compliance
NESHAPs	National Emissions Standards for HAPs

NOAEC	No Observable Adverse Effect Concentration (to Tested Organisms)
NOV	Notice of Violation
NPDES	National Pollution Discharge Elimination System
NRWTF	Non-Radiological Waste Treatment Facility (at ORNL)
NT	Northern Tributary of Bear Creek in Bear Creek Valley
OMI	Operations Management International (runs utilities at ETTP under CROET)
ORAU	Oak Ridge Associated Universities
OREIS	Oak Ridge Environmental Information System http://www-oreis.bechteljacobs.org/oreis/help/oreishome.html
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Association
OSL	Optically Stimulated Luminescent (Dosimeter)
OU	Operable Unit
PACE	Paper, Allied-Industrial, Chemical, and Energy Workers Union
PAM	Perimeter Air Monitor
PER	Potential for Environmental Release
PCB	Polychlorinated Biphenol
pCi	$1x10^{-12}$ Curie (Picocurie)
PCM	Poplar Creek Mile (station location)
pH	Proportion of Hydrogen Ions (acid vs. base)
PWSID	Potable Water Supply Identification "number"
ppb	Parts per Billion
ppm	Parts per Million
ppt	Parts per Trillion
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goals
QA	Quality Assurance
QC	Quality Control
R	Roentgen
RBP	Rapid Bioassessment Program
RCRA	Resource Conservation and Recovery Act
REM (rem)	Roentgen Equivalent Man (unit)
RER	Remediation Effectiveness Report
ROD	Record of Decision
RSE	Remedial Site Evaluation
SLF	Sanitary Landfill
SNS	Spallation Neutron Source
SOP	Standard Operating Procedure
SPOT	Sample Planning and Oversight Team (TDEC)
SS	Surface Spring
STP	**Sewage Treatment Plant or Site Treatment Plan**
SW	Surface Water

TDEC	Tennessee Department of Environment and Conservation
TDS	Total Dissolved Solids
TIE	Toxicity Identification Evaluation
TLD	Thermoluminescent Dosimeter
TOA	Tennessee Oversight Agreement
TRE	Toxicity Reduction Evaluation
TRM	Tennessee River Mile
TRU	Transuranic
TSCA	Toxic Substance Control Act
TSCAI	Toxic Substance Control Act Incinerator
TSS	Total Suspended Solids
TTHM's	Total Trihalomethanes
TVA	Tennessee Valley Authority
TWQC	Tennessee Water Quality Criteria
TWRA	Tennessee Wildlife Resources Agency
U.S.	United States
UT-Battelle	University of Tennessee-Battelle (ORNL Prime Contractor)
VOA	Volatile Organic Analytes
VOC	Volatile Organic Compound
WCK	White Oak Creek Kilometer (station location)
WM	Waste Management
WOL	White Oak Lake
X-####	Facility at X-10 (ORNL)
X-10	Oak Ridge National Laboratory
Y-####	Facility at Y-12
Y-12	Y-12 Plant (Area Office)

APPENDIX B

Tennessee Department of Environment and Conservation
DOE-Oversight Division

JOB HAZARD ANALYSIS

Program Area: **Environmental Monitoring & Compliance**
Section: **Groundwater**
Date: **11/1/07**
Section Supervisor: **John Sebastian**

Job(s):
Collecting water and sediment samples from drinking water supplies, surface water, and ground water.

Potential hazards associated with job(s): _
Automobile accident going to and from monitoring stations.
Physical hazards, slips, trips, falls, temperature extremes.
Animal/Insect stings/bites, infectious diseases transmitted by same, and poisonous plants.
Exposure to ionizing radiation.
Exposure to radioactive contamination, including a potential for the ingestion of radiochemicals.
Exposure to carcinogenic and mutanogenic chemicals.
Exposure to caustic (> 9.0 pH) groundwaters.

Always use protocol and Personal Protective Equipment (PPE) recommended or required for the job(s).

Automobile accidents:
Follow State traffic laws and facility requirements/guidelines.
Always drive defensively.
Physical hazards, slips, trips, falls, and temperature extremes:
Avoid sample collection during adverse weather conditions.
Wear clothing appropriate for the planned activity and weather conditions (boots, gloves, layered clothing).
Visually survey the monitoring area for potential hazards (e.g., slick spots, snow, ice, physical hazards) prior to sampling and take appropriate precautions (avoidance, proper footwear, hard hat).
Animal/insect stings/bites and poisonous plants:
Report known allergies to supervisor/management.
Report and document tick bites to supervisor/management.
Wear appropriate clothing (boots, long sleeves, safety glasses with splash protection, etc.).

Visually survey the sampling areas before entering for evidence of snakes, poisonous plants, insects or any other hazards and avoid any hazards noted.
Use insect repellants (according to directions) as appropriate.

Radiological or chemical contamination:

Always be aware of the potential for radiological or chemical contamination.
Review background information on potential contaminants associated with monitoring locations.
Note any posted warnings or requirements and follow their directions.
Solicit the assistance of site health physicists or industrial hygienists when required (posted) and where background information is unclear.
Follow instructions provided by health physics, industrial hygiene, and/or work permits (where necessary).
Wear PPE and dosimetry as appropriate and/or required.
Personal dosimetry: required
Surgeons and or latex gloves: required
Boots: recommended or required depending on task, steel toed boots may be required in some circumstances
Hard hats: required in some instances
Tyvek booties: required for some tasks.
Tyvek suites: required in rare circumstances
Follow prescribed radiation protection and contamination control procedures (e.g., time, distance, and shielding).
Always survey boots and other areas as appropriate, when leaving sites where there is any potential for loose contamination.

Be cognizant of your surroundings and on the alert for potential hazards to your health or well-being.